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Systematic Review

Effect of soft tissue mobilization techniques on adhesion-related pain and function in the abdomen: A systematic review

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ABSTRACT

Objective: To systematically review the effects of soft tissue mobilization (STM) on both surgical and non-surgical abdominal adhesion-related symptoms.
Study design: Systematic Review.
Background: It is known that abdominal adhesions can cause a variety of symptoms with one of the most common being abdominal pain. To date, there is no known systematic review that documents the effects of STM on adhesion-related abdominal symptoms.
Methods and measures: A systematic review of literature was indexed in the following databases: PubMed, Cochrane, Google Scholar, OVID, and EBSCO. The quality of the studies was assessed using the MINORS scale.
Results: Nine studies satisfied the eligibility criteria for this systematic review. The studies' population age ranged from 10.7 to 89.4 years. Four articles were nonrandomized and had scores ranging from 3 to 14 out of 16 total on the MINORS scale. Five articles were randomized controlled trials or comparative studies and scores ranged from 16 to 23 out of 24 total on the MINORS scale. There were five articles that used pain as an objective measure and all of them reported a decrease in pain after treatment. Two studies looked at quality of life and function and both saw objective improvements following abdominal adhesion treatment. Collectively, there were also improvements seen in scar mobility, infertility, posture, a reduction in medication, increased pressure tolerance and decreased postoperative ileus.
Conclusion: The results of this review indicate preliminary strong evidence for the benefits of STM on symptoms relating to acute post-surgical adhesions, preliminary moderate evidence for the benefits of STM on symptoms relating to chronic non-surgical related adhesions (fertility and SBO) and moderate evidence for the benefits of STM on symptoms relating to chronic post-surgical adhesions.

1. Introduction

Abdominal adhesions are abnormal bands of fibrous tissue that form between two anatomically different structures, causing adherence and restricted visceral mobility (Alpay et al., 2008). It is estimated that 93% of abdominal surgeries result in abdominal adhesions and the most common symptom of abdominal adhesions is chronic abdominal pain (Ward and Panitch, 2011). Adhesions also can form after trauma, infection and inflammation such as with chronic conditions like endometriosis (Alpay et al., 2008). Adhesions are also linked to chronic constipation, small bowel obstruction and infertility (Awonuga et al., 2011; Okabayashi et al., 2014). Adhesiolysis procedures and related problems cost the US medical system billions of dollars per year (National Institute of Diabetes and Digestive and Kidney Diseases, 2013).

Parker et al. in a comprehensive study of postoperative abdominal adhesions reported a ten-year follow up of 12,584 patients in Scotland undergoing colorectal surgery. The authors report that 5.1% of patients were readmitted due to an adhesion-related complication (Parker et al., 2001). Hesselman et al. performed a

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longitudinal review of 15,479 women undergoing gynecologic surgery with a prior history of giving birth. They report that in "women with a previous C-section, adhesions were present in 37%, compared with 10% of women with no previous C-section … Extensive adhesions were reported in 1.9% in women with a history of C-sections compared with 0.2% of women with vaginal delivery" (Hessleman et al., 2018). In addition, the adhesion rate with one C-section was 32%, two C-sections 42% and three or more 59%. Other factors increasing the rate of adhesions included obesity, age and post-partum infection (Hessleman et al., 2018). A meta-analysis of studies on post-operative adhesions by Okabayashi et al. showed an adhesion rate of 51% following obstetric and gynecologic surgery (Okabayashi et al., 2014). In a sub-analysis they reviewed six articles from 2005 to 2011 that focused on the presence of adhesions in C-sections. Six hundred and thirteen of 1988 patients (31%) had adhesions. Four articles reported location of adhesions post C-section. Nineteen to 59 percent had abdominal wall adhesions to the uterus and 19% had adhesions to the omentum. Four articles ranked severity of adhesions at $.77 \pm 1.67$ on a scale of 0–3 (Okabayashi et al., 2014). Awonuga et al. also did a systematic review of adhesion development in gynecologic surgery, and reports an adhesion incidence across all studies on myomectomy (fibroid removal) of 56–94% depending on surgical approach (Awonuga et al., 2011).

Adhesions from a surgical scar may not only contribute to immediate post-operative pain, but also can contribute to the development of local or radiating chronic pain (Kobesova et al., 2007). Adhesions from chronic inflammation or infection also can be a source of pain. Khan et al. reviewed 350 cases of ovarian endometriosis: 86% of women with dense adhesions viewed via laparoscopy reported pain, versus 47% of those with no sign of adhesions (Khan et al., 2013). Okabayashi et al. report that "adhesions account for up to 96% of patients with chronic abdominal and/pelvic pain at diagnostic laparoscopy" (Okabayashi et al., 2014, p. 405). Additionally, as many as 20% of C-sections result in chronic pain according to a study by Nikolajsen et al. (2004). It is unclear why pain develops from these adhesions, though restriction of inter-visceral mobility may be a factor. Articles by Kobesova et al. and Valouchova and Lewit both describe how changes in body position can pull on the adhered tissue and be a source of pain. This in turn can lead to protective movement patterns and abnormal posture (Kobesova et al., 2007; Valouchová and Lewit, 2008). Kobesova et al. postulate that adhesions "… alter the proprioceptive input of the region as a result of compromised tissue tensioning. This faulty afferent input can cause subsequent faulty efferent output, leading to a variety of complications such as protective postural patterns, increased neurovascular activity, and pain syndromes" (Kobesova et al., 2007, p. 235).

According to Awonuga et al., post-operative abdominal adhesions can lead to "infertility with increased risk of ectopic pregnancy should the patient subsequently conceive, abdominal and pelvic pain, bowel obstruction and difficulty with repeat surgical procedures" (Awonuga et al., 2011, p. 1166). Adhesions account for 20–40% of patients with female infertility, and are the only factor in 15% of cases (Awonuga et al., 2011; Okabayashi et al., 2014). In a review of the literature, Awonuga et al. report a study by Lolos that looked at women with tubal infertility and "found that previous abdominal surgery, especially pelvic surgery, was the most frequent risk factor present in 59% of the infertile women followed by pelvic inflammation (42%) and endometriosis (10%)" (Awonuga et al., 2011, p. 1175).

Awonuga et al. also reported that the proportion of small bowel obstructions (SBO) due to adhesions as a result of C- sections ranged from 0.1 to 0.22% and odds increased with repeated C-sections (Awonuga et al., 2011). Okabayashi et al. reported that 60–70% of SBOs are caused by adhesions (Okabayashi et al., 2014).

A number of surgical techniques are used to prevent formation of adhesions including closure of the peritoneum, application of surgical barriers, use of laparoscopy versus laparotomy, use of unpowdered gloves, irrigation, and anti-inflammatories (Alpay et al., 2008; Awonuga et al., 2011; Okabayashi et al., 2014; Brill et al., 1995; Chen et al., 1998; Concado et al., 2012; Lewit and Olsanska, 2004). Once adhesions have formed, surgical management involves a repeat procedure to cut the adhesions (Adhesiolysis). One study reports that adhesiolysis relieves pelvic pain in 60–90% of cases and that adhesiolysis is particularly helpful in treating pain from dense adhesions involving the bowel (Awonuga et al., 2011). Unfortunately inadvertent bowel injury during adhesiolysis can occur in approximately 19% of patients (Awonuga et al., 2011). There is also a concern that by re-operating to perform adhesiolysis, one potentially introduces more trauma to the region and further adhesion development is possible. According to Alpay et al. 97% of subjects have adhesion reformation following adhesiolysis, although adhesion re-formation after adhesiolysis may be less after laparoscopy versus laparotomy (Alpay et al., 2008).

Non-surgical management of presumed abdominal adhesion-related symptoms has focused on various soft tissue scar release techniques. These are variably described in the literature as massage, visceral mobilization, myofascial release, and soft tissue mobilization and are "aimed at restoring skin stretch close to the scar and making all soft tissue layers affected by the scar shift normally one against the other" (Lewit and Olsanska, 2004, p. 400). The objective of this systematic review is to examine the current evidence for the effect of soft tissue mobilization (STM) on both surgical and non-surgical adhesion-related abdominal symptoms.

2. Methods and measures

2.1. Search strategy

Three reviewers conducted an initial search for articles using PubMed, Cochrane, Google Scholar, OVID, and EBSCO. The search term "abdominal scar pain" was used for Google Scholar, Cochrane, and PubMed. The search terms, abdominal scar pain AND treatment OR massage OR myofascial release OR visceral mobilization AND function, were used for EBSCO. From these searches, a total of 110 articles were found. Once appropriate articles were identified, further studies were located by cross-referencing their reference lists. A total of 18 additional articles were identified, making a total of 128 articles.

2.2. Study selection

The reviewers filtered through the articles by removing duplicates. They then screened titles and abstracts, which were found to be appropriate if they discussed manual therapy to the abdomen, scars, abdominal scars, scar pain, or scar treatment. Finally, the reviewers read through the articles in more depth and following this process were left with nine articles appropriate for this systematic review (Fig. 1).

2.3. Inclusion criteria

Studies were included if they met the following criteria: they addressed manual therapy to the conditions affecting the abdomen, and were published in the years 2000–2017.

2.4. Exclusion criteria

Studies were excluded if they contained any of the following:

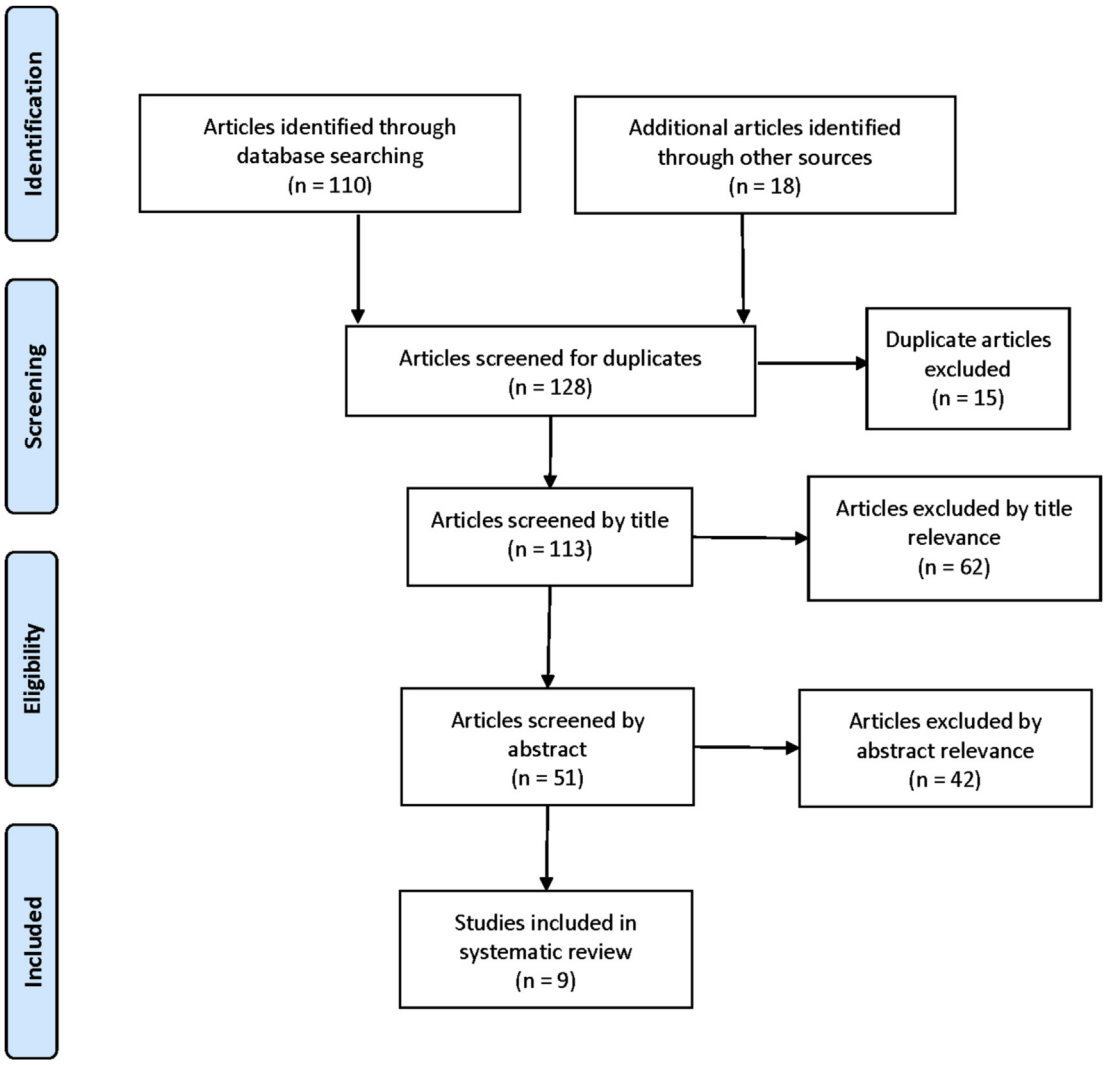

Fig. 1. Screening of articles flow sheet.

they were not in English, not peer reviewed, and if the main focus did not relate to manual interventions of the abdomen for either surgical or non-surgical adhesion-related symptoms.

2.5. Data extraction

Reviewers independently extracted the following data from each of the nine articles included in this study: author/year of publication, research design, number of subjects, interventions, outcome measures and results.

2.6. Methodological quality

The Methodological Index for Non-Randomized studies (MINORS) scale was used to assess the methodological quality for all nine articles including randomized controlled trials (RCTs) and non-RCTs. The MINORS scale is a validated instrument to determine the methodological quality of observational or nonrandomized studies, though it has additional criteria to allow one to rate RCT's as well (Slim et al., 2003) (Fig. 2). Articles that were not randomized were scored on items 1–8; articles that included a comparison group were scored on items 1–12. Each reviewer was responsible for rating a third of the articles using the MINORS scale. The results were then cross-referenced by the other reviewers and any discrepancies were discussed and modified as needed. For positive findings we considered scores in the upper quartile (18–24/24 or 12–16/16) to be strong evidence, second quartile (12–17/24 or 8–11/16) to be moderate and lower half (<12/24 or < 8/16) to be preliminary/weak evidence. We also ranked articles according to the guidelines of the Oxford Centre for Evidence Based Medicine (CEBM) - Levels of Evidence (Oxford Centre for Evidence-based Medicine Levels of Evidence, 2009).

2.7. Data analysis

The methodological quality, statistical results, and strengths and weaknesses of research designs were evaluated to draw conclusions regarding the strength of evidence to support the use of manual therapy for relief of adhesion-related abdominal symptoms.

3. Results

One hundred and ten articles were identified from five databases. Eighteen additional studies were identified through examining research studies and their references. After removal of

Methodological items for non-randomized studies
1. **A clearly stated aim:** the question addressed should be precise and relevant in the light of available literature
2. **Inclusion of consecutive patients**: all patients potentially fit for inclusion (satisfying the criteria for inclusion) have been included in the study during the study period (no exclusion or details about the reasons for exclusion)
3. **Prospective collection of data**: data were collected according to a protocol established before the beginning of the study
4. **Endpoints appropriate to the aim of the study**: unambiguous explanation of the criteria used to evaluate the main outcome which should be in accordance with the question addressed by the study. Also, the endpoints should be assessed on an intention-to-treat basis.
5. **Unbiased assessment of the study endpoint**: blind evaluation of objective endpoints and double-blind evaluation of subjective endpoints. Otherwise the reasons for not blinding should be stated
6. **Follow-up period appropriate to the aim of the study**: the follow-up should be sufficiently long to allow the assessment of the main endpoint and possible adverse events
7. **Loss to follow up less than 5%**: all patients should be included in the follow up. Otherwise, the proportion lost to follow up should not exceed the proportion experiencing the major endpoint
8. **Prospective calculation of the study size**: information of the size of detectable difference of interest with a calculation of 95% confidence interval, according to the expected incidence of the outcome event, and information about the level for statistical significance and estimates of power when comparing the outcomes
Additional criteria in the case of comparative study
9. **An adequate control group**: having a gold standard diagnostic test or therapeutic intervention recognized as the optimal intervention according to the available published data
10. **Contemporary groups**: control and studied group should be managed during the same time period (no historical comparison)
11. **Baseline equivalence of groups**: the groups should be similar regarding the criteria other than the studied endpoints. Absence of confounding factors that could bias the interpretation of the results
12. **Adequate statistical analyses**: whether the statistics were in accordance with the type of study with calculation of confidence intervals or relative risk

Fig. 2. Revised and validated version of MINORS scale (Slim et al., 2003).

duplicates and completing the screening process for eligibility, there were a total of nine articles to be used for this systematic review. Common reasons for article exclusion were articles that were not peer reviewed and treatment that was not manual in nature. Table 1 summarizes each included article.

3.1. Methodological analysis

Table 2 lists the Minors scale scoring for each article. There were five RCT studies which all scored a 23/24 and one comparative study that scored a 16/24. The first four were considered strong studies and the fifth moderate based on our criteria. The remaining articles consisted of pilot studies, case studies, and quasi-experimental studies. Of those articles, one study scored 14/16 (strong evidence), two studies scored 11/16 (moderate evidence), one study scored 4/16 and one study scored 3/16. These latter two were considered preliminary/weak evidence.

3.2. Subjects

The total number of subjects within these studies included 220 humans and 70 rats. All subjects had some form of STM treatment completed in order to attempt to alleviate adhesion-related abdominal symptoms.

3.3. Experimental interventions

Interventions consisted of visceral massage, myofascial induction therapy (MIT), hot pack combined with STM (superficial and deep), mechanical abdominal massage, as well as pelvic and abdominal diaphragm myofascial release or direct scar release. Outcome measures included: adhesion severity score, assessment of scar appearance, palpation of scar depth, measurement of tissue restriction, pain scales Numeric Pain Rating Scale (NPRS) and Visual Analog Scale (VAS), Pain Pressure Threshold, reduction in medications, Oswestry Disability Index, Schober's Test for lumbar flexion, Quality of Life and Small Bowel Obstruction questionnaires, bowel movements, and fertility successes.

3.4. Chronic post-surgical abdominal scars

Four of the articles in this review looked at chronic post-surgical abdominal scars. They are summarized in Table 3. Three of these assessed pain as an outcome. Kobesova et al. studied the effects of hot packs and manual mobilization techniques on an individual with chronic pain stemming from an appendectomy. Their single subject case study found a decrease in pain and improved posture and function following nine treatment sessions. However this was a weak level of evidence with a MINORS score of 4/16 due to factors including sample size, poor description of intervention and lack of validated measures (Kobesova et al., 2007). CEBM level of evidence was 4 (poor quality case control study) (Oxford Centre for Evidence-based Medicine Levels of Evidence, 2009). Lewit et al. also used hot packs and manual soft tissue treatment and reported that 36/51 patients experienced a decrease in subjective reports of pain after the first exam. However, as only 29/51 subjects had abdominal scars it is difficult to know how many of the abdominal scar subjects experienced pain relief. The study design was weak (MINORS score 3/16) with no validated outcome measures and inadequate description of treatment or follow up, so it is difficult to draw meaningful conclusions (Lewit and Olsanska, 2004). CEBM level of evidence was 4 (case-series) (Oxford Centre for Evidence-based Medicine Levels of Evidence, 2009).

Wasserman et al. performed a randomized clinical trial with 28 subjects, comparing the effectiveness of four half-hour sessions of superficial versus deep fascial techniques on alleviating chronic pain resulting from C-section surgery (Wasserman et al., 2018). Both groups showed statistically significant improvement in pain

Table 1
Study summary.

Author & Year of Publication	Research Design	#/type of Subjects	Intervention	Outcome Measure	Results	Minor Score
Bove and Chapelle (2012)	RCT	30 rats Surgically abraded colons	10- no intervention 10- daily visceral massage x 7 days 10-visceral massage day 7	Adhesion Severity Score	Both experimental groups showed evidence of recently torn adhesions. Prevention group (daily intervention) had less adhesions than other two	23/24
Chapelle and Bove (2013)	RCT	40 rats (Half surgically abraded colons)	10- surgery + visceral massage 10- surgery only 10- visceral massage only 10- no intervention	At 24 h post op: Time to first fecal discharge Fecal pellet counts, GI transit time, inflammatory cells	Visceral massage reduced experimental postoperative ileus and lowered intraperitoneal inflammatory cells	23/24
Comesaña et al. (2016)	Pilot Study/ quasi-experimental	10/asymptomatic C-sections > 18 month duration	Myofascial induction therapy (MIT) 8 weekly sessions of 30 min each	Assessment of the scar surface, US to assess depth of scar and tissues, Schober's Test, QOL using SF-36 questionnaire	MIT improved scar structure, function and QOL.	11/16
Kobesova et al. (2007)	Case Study	1 with abdominal scar 20 year duration with chronic abdominal pain	Hot pack and manual soft tissue treatment 1–2x/week for 6 weeks (total of 9 treatments)	Palpation of restrictive scar tissue and subjective pain reports from patient	STM of active scar eliminated pain, improved posture and function.	4/16
Le Blanc-Louvry et al. (2002)	RCT	50 subjects acute post colectomy	Daily for 7 days post op Mechanical abdominal massage with the Cellu M50 handheld massage device for 15 min each session	VAS 0–10 pain scale, daily doses of pain medication	The treatment group showed a reduction in pain scores, reduction in medication use and duration of the ileus compared to the control	23/24
Lewit and Olsanska (2004)	Multiple case studies	51 with myofascial pain and a surgical scar. 29 were abdominal scars	Hot pack and soft tissue manipulation superficial and deep	Subjective reduction in pain	36/51 scars showed immediate results after the first treatment	3/16
Rice et al. (2016)	Quasi-experimental (pretest/ posttest)	27 Hx of small bowel obstruction from adhesions	CPA- myofascial release/ visceral manipulation. 20 h over 5 days	SBO-Q (small bowel obstruction questionnaire), ROM measurements	Sign. decrease in general pain, head and neck pain, pain with eating, bloating. Improved QOL- (missed time from work, social and ADL)	12/16
Wasserman et al. (2018)	Randomized Clinical Trial	28- chronic C-section scar pain	Pelvic and abdominal diaphragm myofascial release, direct scar release, skin roll, lumbo-thoracic massage	NPRS, pressure algometer (PPT), scar mobility, Oswestry Disability Index (ODI). Global Rating of Change (GROC)	Pain, PPT, scar mobility, ODI, GROC all shoed sign. Improvements ($p < 0.002$) in both groups. No difference between groups. Sustained over 10 weeks post Rx.	24/24
Wurn et al. (2004)	Quasi-experimental Post-test only Control comparison to national fertility stats	a) 17 infertile women hoping to become "naturally" pregnant. b) 36 infertile women planning IVF in next year. All infertility due to confirmed or suspected adhesions from surgery, trauma, or inflammation	CPA- myofascial release/ visceral manipulation. Median 11 h of therapy over 1–24 weeks	a) Natural Pregnancy within 1 year of last Rx date b)pregnancy from IVF within 15 months of last Rx date	a) 10/14 (71.4%) became pregnant 3 lost to follow up b) 22/33 embryo transfers resulted in pregnancies (vs 12.7/33 expected from CDC reports on IVF results.) Odds ratio for successful pregnancy in cycle (manual Rx vs not) 3.2 (95% CI = 1.55–8.4)	16/24

Table 2
MINORS scale results.

MINORS criterion	Bove et al.	Chappelle et al.	Comensana et al.	Kobesova et al.	Lewit et al.	Le Blanc et al.	Rice et al.	Wasserman et al.	Wurn et al.
1-A clearly stated aim	2	2	2	2	1	2	2	2	2
2-Inclusion of consecutive patients	2	2	2	0	1	2	0	2	1
3-Prospective collection of data	2	2	2	0	0	2	2	2	2
4-Endpoints appropriate to the aim of the study	2	2	2	1	1	2	2	2	1
5-Unbiased assessment of the study endpoint	2	2	0	0	0	2	0	2	1
6-Follow up period appropriate to the aim of the study	2	2	1	1	0	2	2	2	2
7-Loss to follow up less than 5%	2	2	2	0	0	2	2	2	2
8-Prospective calculation *Additional criteria in the case of comparative study*	1	1	0	0	0	2	2	2	1
9-An adequate control group	2	2	–	–	–	2	–	1	1
10-Contemporary groups	2	2	–	–	–	2	–	2	1
11-Baseline equivalence of groups	2	2	–	–	–	2	–	2	0
12-Adequate statistical analysis	2	2	–	–	–	1	–	2	2
Finalized MINORS scale	*23/24*	*23/24*	*11/16*	*4/16*	*3/16*	*23/24*	*12/16*	*23/24*	*16/24*

measured by pressure algometer (pressure pain threshold-PPT) and the numeric pain rating scale (NPRS) with $p < 0.001$. This pain improvement was sustained at 6–10 week follow up following intervention. They did a repeat baseline measure one month apart to establish stability and identified that time alone did not account for a change in outcomes, but this cannot be considered a true sham control. This is considered a strong study with a MINORS score of 23/24. CEBM level of evidence was 1b (individual RCT) (Oxford

Table 3
STM in chronic post-surgical abdomen.

Authors	MINORS score	CEBM level of evidence	N	Main Outcomes	Weakness
Comesana et al.	11/16	2b	10	Scar Thickness	Small N No comparison Group
Kobesova et al.	4/16	4	1	Pain	Small N No comparison Group Poorly Defined outcomes Poorly Defined Interventions
Lewit et al.	3/16	4	29	Pain	No comparison Group Poorly Defined outcomes Poorly Defined Interventions
Wasserman et al.	23/24	1b	28	Pressure Pain Threshold Scar Mobility Numeric Pain Rating Scale, Oswestry Disability	No concurrent sham control (control was 2 baseline measures prior to start of intervention)

Centre for Evidence-based Medicine Levels of Evidence, 2009).

Two of the articles looked at other outcomes aside from pain. The article by Comesaña et al. used a form of myofascial mobilization (MIT) on chronic C- section scars and found that it was able to decrease scar thickness as measured via ultrasound, and improve function and quality of life. Even though the study was a pilot study with ten subjects, it was promising to note that structural changes were seen in all subjects and in scars that had completed the remodeling process. They analyzed the effects of repeated treatments and concluded that eight visits maximized the treatment benefits (Comesaña et al., 2016). This study provides moderate evidence with a MINORS score of 11/16 with weaknesses being a lack of stated blinding of assessors, inadequate follow up time and a small sample size. CEBM level of evidence was 2b (individual cohort study) (Oxford Centre for Evidence-based Medicine Levels of Evidence, 2009).

The Wasserman study also reported a significant increase in scar mobility, improved function and improved Global Rating of Change Scale. Cumulatively, these articles provide moderate evidence that STM to chronic abdominal scars may decrease patient's pain, and strong evidence that STM increases scar mobility, decreases scar thickness and improves function and quality of life. However, the four studies varied on treatment duration and frequency so recommended treatment parameters cannot be determined. CEBM grade for this group of studies was A/C (combination of level 1–4 studies) (Oxford Centre for Evidence-based Medicine Levels of Evidence, 2009).

3.5. Acute post-surgical abdominal scars

Three articles included in this systematic review researched acute post-surgical abdominal scars. They are summarized in Table 4. All of them were well designed with MINORS score of 23/24 and all of them were CEBM level 1b (individual RCT) (Oxford Centre for Evidence-based Medicine Levels of Evidence, 2009). One of these assessed pain. LeBlanc et al. used a handheld device to deliver a mechanical abdominal massage once a day following surgery until postoperative day seven. Fifty subjects post-colectomy were included in this study and they had a significant reduction both in pain scores on the VAS and in pain medication use (Le Blanc-Louvry et al., 2002). Two articles addressed the duration of post-operative ileus. The LeBlanc et al. article described above demonstrated a reduced time of ileus with mechanical STM. Chapelle et al. performed abdominal surgery on rats and found that visceral massage reduced postoperative ileus (Chapelle and Bove, 2013). The article by Bove et al. looked at the presence of adhesions as an outcome. They performed colon abrasion to create adhesions followed by visceral mobilizations (VM). One group had daily VM, a second group had VM only on day seven and a third group had no intervention. The study demonstrated that both experimental groups had positive outcomes of recently torn adhesions, with the daily intervention group having roughly half the number of adhesions present at day 7 ($p < .01$) (Bove and Chapelle, 2012). CEBM grade for this group of studies was A (consistent level 1 studies) (Oxford Centre for Evidence-based Medicine Levels of Evidence, 2009). Cumulatively these studies provide strong evidence for the effect of manual therapy in preventing adhesions, reducing pain and medication use, and improving ileus in the acute post-operative abdomen. However, it is important to recognize that the studies by Bove et al. and Chapelle et al. used rats as their subjects which makes it difficult to generalize their findings to the human population.

3.6. Chronic non-surgical abdominal adhesion-related symptoms

Finally, two articles examined chronic non-surgical symptoms related to abdominal adhesions. They are summarized in Table 5. The article by Rice et al. had 27 subjects with a history of small bowel obstruction resulting from adhesions. Their treatment consisted of myofascial release and visceral manipulation for 20 h over five days. Results showed a significant decrease in general pain and improved quality of life. The MINORS score was 12/16 as the study did not include enough detailed information to be replicated and did not have a control group but still provides a strong level of

Table 4
STM in acute post-surgical abdomen.

Authors	MINORS score	CEBM level of evidence	N	Main Outcomes	Weakness
Bove et al.	23/24	1b	30 rats	Decreased Adhesions	Non-human
Chapelle et al.	23/34	1b	40 rats	Post-op Ileus Decreased Inflammatory cells	Non-human
LeBlanc et al.	23/24	1b	50	Post-op Ileus Pain Medication Use Pain Reports	Mechanical Massage

Table 5
STM in chronic non-surgical abdomen.

Authors	MINORS score	CEBM level of evidence	N	Main Outcomes	Weakness
Rice et al.	12/16	2b	27	Quality of Life Pain	No Comparison Group Poorly Defined Interventions
Wurn et al.	16/24	2b	53	Pregnancy	Poorly Defined Control Group Poorly Defined Interventions

evidence (per our stated criteria above) of a positive effect from STM on chronic symptoms resulting from SBO (Rice et al., 2016). CEBM level of evidence was 2b (individual cohort study) (Oxford Centre for Evidence-based Medicine Levels of Evidence, 2009).

Wurn et al. had 53 subjects that had infertility due to suspected abdominal adhesions. Subjects also received myofascial release and visceral manipulation for a median of 11 h over anywhere from one to 24 weeks. Following treatment, 10 women were able to get pregnant naturally and 22 had successful embryo transplants compared to an expected rate of 12.7 successful embryo transplants in an age-matched population without manual therapy treatment. MINORS scale was 16/24 as the study lacked a true control group and a detailed description of interventions (Wurn et al., 2004). CEBM level of evidence was 2b (individual cohort study). CEBM grade for this group of two studies was B (consistent level 2 or 3 studies) (Oxford Centre for Evidence-based Medicine Levels of Evidence, 2009). The two studies together provide moderate evidence suggesting that soft tissue techniques may be helpful in improving fertility and reducing pain in adhesion-related abdominal conditions. Unfortunately, there were not enough details given on treatment techniques and treatment time varied widely so it is difficulty to develop recommendations for treatment parameters.

4. Comment

Manual therapy practitioners have long been performing this type of intervention under the auspices of treating back and pelvic pain. Anecdotal evidence has suggested that STM in the abdomen is useful in treating pain, ileus and fertility but there has not been a previous systematic review of available literature. This systematic review studied the effects of STM on abdominal surgical and non-surgical adhesion-related symptoms. There were nine articles, which included both randomized and non-randomized trials that related to STM and abdominal adhesions. The articles reviewed provides strong evidence for the benefits of STM on symptoms relating to acute post-surgical adhesions, moderate evidence for the benefits of STM on symptoms relating to chronic non-surgical related adhesions (fertility and SBO) and moderate evidence for the benefits of STM on symptoms relating to chronic post-surgical adhesions.

We have seen from this review that there is moderate to strong evidence to support the use of abdominal STM immediately post-abdominal surgery to prevent ileus, reduce pain medication use and probably to lessen adhesion formation. Long-term studies on humans need to be done to see if post-operative massage will lessen the incidence of chronic post-operative pain.

This review also provides preliminary support for the use of STM in infertility. Though the reported study scored in the “moderate” range, there was only one study available looking at fertility as an outcome. Future studies will need to replicate this. Similarly, only one study reported examined the effects of STM on symptoms related to SBO. Though the study also scored in the moderate range for quality, the results will need to be duplicated in the future.

The studies examining treatment of chronic symptoms from abdominal scars provide moderate evidence that scar mobility, thickness, pain, and quality of life can be improved by four to eight sessions of STM. Future studies need to examine abdominal surgeries other than C-sections, and clarify the benefits of various STM techniques.

4.1. Limitations

There are several limitations to this systematic review. Because of the nature of a systematic review, they are subject to article retrieval bias. Despite the best intentions of the reviewers, appropriate articles may have been missed throughout their selection process. Of the nine articles included, only three were RCTs, two of which had non-human subjects. Many of the articles did not have a large enough sample size to generate strong statistical power. Our studies also included a variety of interventions and outcome measures which made it difficult to delineate a standardized treatment protocol.

5. Conclusion

The results of this systematic review conclude that there is preliminary strong evidence that STM applied to acute surgical abdominal adhesions has a positive outcome on pain, and function; preliminary moderate evidence for STM in treating chronic non-surgical abdominal symptoms and preliminary weak evidence for STM in treating pain, function and mobility in the chronic post-surgical abdomen. While a variety of techniques were used and sample sizes were small, there were no adverse effects resulting from treatment. Future studies should include larger sample sizes with more randomized control trials and clearly delineated, validated outcomes to clarify the optimal treatment parameters and specific conditions most effectively treated by these techniques.

References

Alpay, Z., Saed, G.M., Diamond, M.P., 2008. Post operative adhesions: from formation to prevention. Semin. Reprod. Med. 26 (4), 313–321.
Awonuga, A.O., Fletcher, N.M., Saed, G.M., Diamond, M.P., Dec 2011. Postoperative adhesion development following cesarean and open intra-abdominal gynecological operations: a review. Reprod. Sci. 18 (12), 1166–1185.
Bove, G., Chapelle, S., 2012. Visceral mobilization can lyse and prevent peritoneal adhesions in a rat model. J. Bodyw. Mov. Ther. 16 (1), 76–82.
Brill, A.I., Nezhat, F., Nezhat, C.H., Nezhat, C., Feb 1995. The incidence of adhesions after prior laparotomy: a laparoscopic appraisal. Obstet. Gynecol. 85 (2), 269–272.
Chapelle, S., Bove, G.M., 2013. Visceral massage reduces postoperative ileus in a rat model. J. Bodyw. Mov. Ther. 16 (1), 76–82.
Chen, R.N., Moore, R.G., Cadeddu, J.A., et al., Apr 1998. Laparoscopic renal surgery in patients at high risk for intra-abdominal or retroperitoneal scarring. J. Endourol. 12 (2), 143–147.
Comesaña, S., Vicente, M., Ferreira, T., Perez-La fuente Varela, M., Quintans, M., Pilat, A., 2016. Effect of myofascial induction therapy on post-c-section scars, more than one and a half years old. Pilot study. J. Bodyw. Mov. Ther. 21 (1), 197–204.
Concado, T., Omais, M., Ashmawi, H., Torres, M., 2012. Chronic pain after cesarean section. Influence of anesthetic/surgical technique and postoperative analgesia. Rev. Braz. Anestesiol. 62 (6), 762–774.
Hessleman, S., Hogberg, U., Rassjo, E., Schytt, E., Lofgren, M., Jonsson, M., 2018 Apr. Abdominal adhesions in gynaecologic surgery after caesarean section: a longitudinal population based register study. BJOG An Int. J. Obstet. Gynaecol. 125 (5), 597–603. https://doi.org/10.1111/1471-0528.14708.
Khan, K.N., Kitajima, M., Fujishita, A., et al., Jan 2013. Pelvic pain in women with ovarian endometrioma is mostly associated with coexisting peritoneal lesions. Hum. Reprod. 28 (1), 109–118.
Kobesova, A., Morris, C., Lewit, K., Safarova, M., 2007. Twenty-year-old pathogenic

"active" postsurgical scar: a case study of a patient with persistent right lower quadrant pain. J. Manip. Physiol. Ther. 30 (3), 234–238.
Le Blanc-Louvry, I., Costaglioli, B., Boulon, C., Leroi, A.M., Ducrotte, P., Jan-Feb 2002. Does mechanical massage of the abdominal wall after colectomy reduce post-operative pain and shorten the duration of ileus? Results of a randomized study. J. Gastrointest. Surg. 6 (1), 43–49.
Lewit, K., Olsanska, S., Jul-Aug 2004. Clinical importance of active scars: abnormal scars as a cause of myofascial pain. J. Manip. Physiol. Ther. 27 (6), 399–402.
National Institute of Diabetes and Digestive and Kidney Diseases, US Department of Health and Human Services, 2013. Abdominal Adhesions. https://www.niddk.nih.gov/health-information/digestive-diseases/abdominal-adhesions. (Accessed 4 February 2017).
Nikolajsen, L., Sorensen, H.C., Jensen, T.S., Kehlet, H., Jan 2004. Chronic pain following caesarean section. Acta Anaesthesiol. Scand. 48 (1), 111–116.
Okabayashi, K., Ashrafian, H., Zacharakis, E., et al., Mar 2014. Adhesions after abdominal surgery: a systematic review of the incidence, distribution and severity. Surg. Today (Tokyo) 44 (3), 405–420.
Oxford Centre for Evidence-based Medicine Levels of Evidence, 2009. http://www.cebm.net/oxford-centre-evidence-based-medicine-levels-evidence-march-2009/. (Accessed 14 July 2017).
Parker, M., Ellis, H., Moran, B.J., et al., 2001. Postoperative adhesions: ten-year follow-up of 12,584 patients undergoing lower abdominal surgery. Dis. Colon Rectum 44 (6), 822–829.
Rice, A., Patterson, K., Reed, E., et al., 2016. Treating small bowel obstruction with a manual physical therapy: a prospective efficacy study. Hindawi Publishing Corporation BioMed Res. Int. 2016, 8. https://doi.org/10.1155/2016/7610387. Article ID: 7610387.
Slim, K., Nini, E., Forestier, D., Kwiatkowski, F., Panis, Y., Chipponi, J., 2003. Methodological index for non-randomized studies (MINORS): development and validation of a new instrument. ANZ J. Surg. 73, 712–716.
Valouchová, P., Lewit, K., 2008. Influence of active scars in abdominal wall on abdominal and back muscles activity in chronic low back pain – surface electromyography pilot study. Int. Muscoskel. Med. 30 (3), 128–132.
Ward, B., Panitch, A., 2011. Abdominal adhesions: current and novel therapies. J. Surg. Res. 165 (1), 91–111.
Wasserman, J., Abraham, K., Massery, M., Chu, J., Farrow, A., Marcoux, B., June 2018. Soft tissue mobilization techniques are effective in treating chronic pain following caesarean section: a multi-center randomized clinical trial. J. Women's Health Phys. Ther. https://doi.org/10.1097/JWH.0000000000000103.
Wurn, B., Wurn, L., Roscow, A., et al., 2004. Treating female infertility rates with a manual physical therapy technique. MedGenMed 6 (2).