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CLINICAL REVIEW

The anatomy, biological plausibility and efficacy of visceral mobilization in the treatment of pelvic floor dysfunction

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Abstract

This paper provides an overview of the technique of visceral mobilization. Founded on the principles of osteopathic manipulative therapy, this modality is employed by manual therapy practitioners throughout the world. Advancements in the field of pelvic physiotherapy have generated a better understanding of how the components of the abdominopelvic canister work synergistically to support the midline of the body and contribute to normal function. The walls of this canister are occupied by and intimately connected to the visceral structures found within the abdominal cavity. These midline contents carry a significant mass within the body, and affect the function of the somatic frame in three ways: referred visceral pain; central sensitization; and changes in local tissue dynamics. The evidence supporting visceral mobilization therapy (VMT) is limited, and there is an overabundance of case reports and observational studies in the literature. However, there is some higher-level clinical evidence that supports the inclusion of VMT within a comprehensive treatment programme for a number of pelvic physiotherapy diagnoses, including lower urinary tract dysfunction, chronic constipation and irritable bowel syndrome. The evidence supporting VMT for the treatment of adhesion-related disorders such as infertility shows promise, and further studies are currently in progress.

Keywords: fascia, manual therapy, osteopathy, pelvic dysfunction, visceral mobilization.

Introduction

> "All organs, muscles, and body structures must be viewed in the context of the surrounding connective tissues and distant blood and lymphatic fluid flow; specific pathology cannot be fully understood or treated without taking those tissues into account." (Findley 2011, p. 5)

The field of pelvic physiotherapy has moved far beyond its origins. Initially concerned primarily with the rehabilitation of the pelvic floor muscles (PFMs) for the purpose of restoring continence, it has now become a comprehensive specialty within the profession, and is used to treat a variety of populations and conditions (Haslam & Laycock 2015).

Clinical research has led to a greater understanding of the abdominopelvic canister. This functional and anatomical construct is based on the somatic structures of the abdominal cavity and pelvic basin, which work synergistically to support the midline of the body. The canister is bounded by: the respiratory diaphragm and crura; the psoas muscles, the fascia of which intimately blends with the pelvic floor and the obturator internus; and lastly, the transversus abdominis muscle (Lee *et al.* 2008).

When discussing the musculoskeletal (MSK) canister, it must be remembered that it is indeed a repository, and therefore, has contents. These take the form of the abdominal and pelvic viscera (Fig. 1), which, along with the fascial envelopes that attach these organs directly to the

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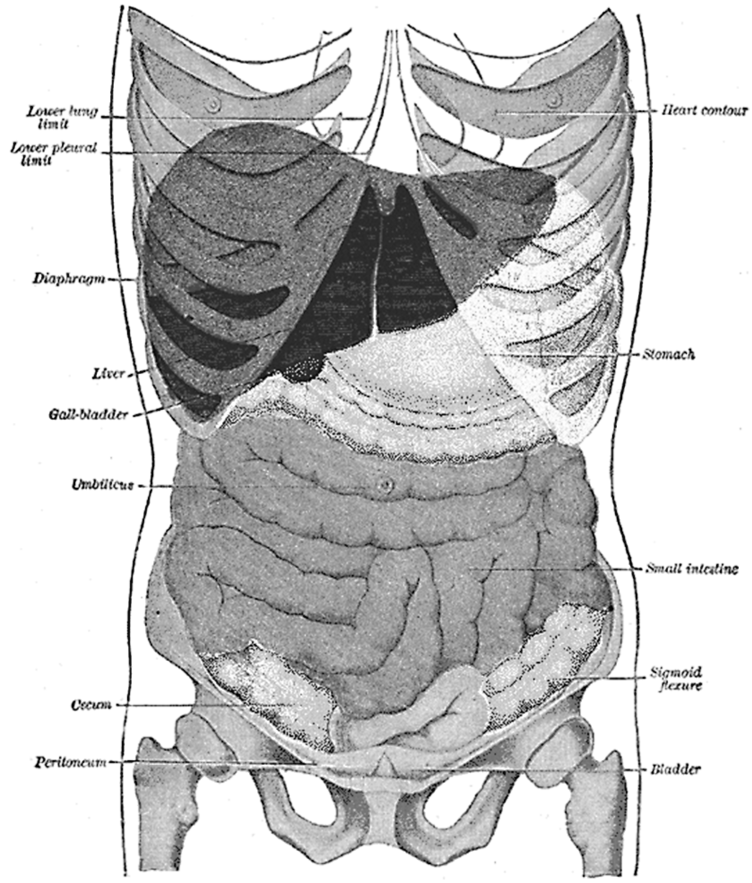

Figure 1. The visceral structures represented as the contents of the musculoskeletal canister (illustration: Gray 1918, Fig. 1224, p. 1318).

canister, provide the foundation for the evaluation and potential treatment of the visceral structures. In order for the canister to move, the viscera must be able to move as well, not only in relationship to one another, but also with respect to the surrounding container. There are three primary mechanisms by which disruption of these sliding surfaces could contribute to pain and dysfunction: referred visceral pain; central sensitization; and changes in local tissue dynamics.

As the creator and instructor of a series of educational courses dealing with visceral mobilization therapy (VMT) for the treatment of pelvic floor dysfunction, the present author is frequently asked to provide evidence of the efficacy of this modality. There is a paucity of higher levels of evidence in support of the manual mobilization of the internal organs as an individualized treatment technique, and therefore, we must rely on current fascial research and biological plausibility. Furthermore, with the understanding that the visceral structures carry a significant mass within the human frame, VMT can be seen as simply a form of soft-tissue manual therapy that addresses the fascial attachments of the visceral structures mentioned above.

Biological plausibility

In situations where higher-level research evidence is insufficient, the application of related research and a thorough knowledge of known scientific principles can offer guidance for appropriate clinical reasoning. In order to accept the biological plausibility of the application of manual therapy to the internal organs as a viable treatment technique, we must focus on the sciences of anatomy, physiology and physics, which provide the following information:

(1) The visceral structures represent the entire contents of the bodily cavities, carry a significant mass within these, and are subject to the same laws of physics and types of trauma as the locomotor system (Davis *et al.* 1976; Cox 1984). Sources estimate the collective mass of the viscera to be an average of 12% of total body weight (Schwartz *et al.* 1994).

(2) The internal organs articulate with one another through a double-layered system of

Table 1. Sympathetic innervations and pain referral sites of the visceral structures

Organ	Sympathetic innervation	Pain referral sites
Stomach	T5–T9	Epigastric region, lower thoracic spine
Small intestine	T8–T10	Mid-thoracic spine
Large intestine	T11–L1	Lower abdominal region, mid-lumbar spine
Cecum/appendix	T10	Lower right abdominal quadrant, iliacus muscle
Sigmoid colon	L1–S2	Upper sacral region, suprapubic region, lower left abdominal quadrant, iliacus muscle
Liver	T7–T9	Right mid-to-lower thoracic spine, right cervical spine
Kidney	T10–L1	Lumbar spine, lower abdominal region
Ureter	T11–L2	Groin, suprapubic region, proximal medial thigh
Urinary bladder	T11–L2	Sacral apex, suprapubic region
Prostate gland	T11–L1	Sacral region, testicles
Uterus	T12–L1	Lower abdomen and sacrum
Ovary and testis	T10–T11	Lower abdomen and groin

serous membranes, i.e. the pleura, pericardia and peritonea. These are required to glide and displace during the normal functions of respiration, trunk movement, digestion and elimination (Barral & Mercier 1988; Brandner *et al.* 2006; Bove & Chapelle 2011).

(3) The visceral structures are attached to the somatic frame by a vast network of fascial attachments (Otcenasek *et al.* 2008; Hedley 2010; Willard 2012a; Bordoni & Zanier 2013).

(4) These connective tissue attachments have an influence on the biomechanics of the somatic frame. In the adult male, the liver has been show to weigh between 838 and 2584 g. It attaches under the diaphragm to the right side of the body, causing anatomical asymmetry. The liver moves an average of 3 cm with every respiration, and since it does this approximately 20 000 times in a 24-h period, this means that it travels around 96.6 km a year. The weight range of the kidneys is between 74 and 235 g. These organs lie directly over the psoas and quadratus lumborum, and are attached to these muscles by the renal fascia. The kidneys also move 3–4 cm with each respiration (Schwartz *et al.* 1994; Molina & DiMaio 2012).

(5) Nociceptive stimuli have long been known to refer pain to the somatosensory system via the viscerosomatic reflex, and affected areas include the abdominal wall and lumbopelvic region (see Table 1). Visceral nociceptors are activated by ischaemia and inflammation, as well as purely mechanical events including distention of hollow organs and traction on the mesentery (McMahon & Abel 1987; Wesselmann & Lai 1997; Goodman & Snyder 2007).

(6) The contraction of the intestinal walls is regulated by a rich neural network that functions independently of the central nervous system. This enteric nervous system contains more neurons than the entire spinal cord, and is governed by the same neurotransmitters that control the brain (Gershon 1999).

(7) Visceral dysfunction (e.g. inflammation and the distention seen in chronic constipation) contributes to central sensitization and chronic pain states (McMahon & Abel 1987; Binnebösel *et al.* 2008; Rickenbacher *et al.* 2008; Goehler 2011).

(8) Scarring of the abdominal and thoracic walls as a result of surgery or penetrating wounds has been shown to affect the soft tissues in multiple layers. Loss of mobility extends from the epidermis through the subcutaneous tissue to the muscular and the visceral structures, and may contribute to local tissue dysfunction and pain states (Lewit & Olsanska 2004; Hedley 2010; Bordoni & Zanier 2014).

(9) Viscerovisceral and visceroparietal adhesions are a common occurrence following trauma, surgical intervention, tumours and inflammatory processes (Menzies & Ellis 1990; Ellis 1997; Hedley 2010). Adhesions are innervated, are capable of generating local as well as referred pain, and can contribute to issues such as constipation, small bowel obstruction, pelvic pain, infertility and repeated surgery (Diamond & Freeman 2001; Sulaiman *et al.* 2001; Binnebösel *et al.* 2008).

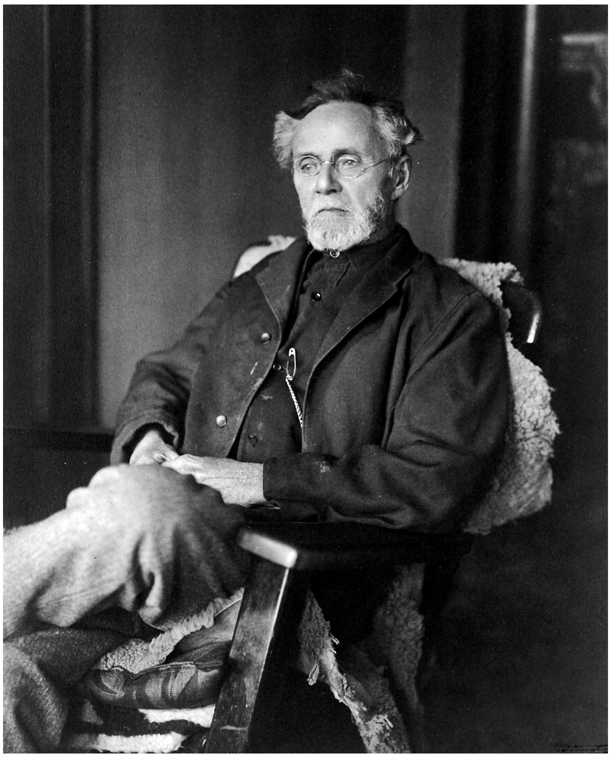

Figure 2. Andrew Taylor Still (photograph: Library of Congress collection): "All organs have a covering of this substance, though they may have names to suit the organs, surfaces, or parts spoken of" (Still 1899, p. 166).

Origins in osteopathy

Beginning with the foundational work of Andrew Taylor Still in the nineteenth century (Fig. 2), the vast majority of manual therapy techniques practised today by multiple disciplines, including physiotherapy, are derived from osteopathic manipulative therapy (OMT) (Greenman 2003; King & Patterson 2011), and VMT is no exception (Barral & Mercier 1988; Kuchera & Kuchera 1992; Stone 2007; Hebgen 2010; Helsmoortel *et al.* 2010). A core element of OMT is the belief that the body is a total unit, i.e. that the neuromusculoskeletal system is connected with the body's other systems, and therefore, the treatment of any dysfunction should not be carried out in isolation (Still 1902; Greenman 2003).

Visceral dysfunction is defined as the impaired mobility of a visceral structure, and all related fascial, neurological, vascular, skeletal and lymphatic elements. It is indicated by abnormal motion testing results, i.e. alterations in the distensibility of regional attachments. Visceral mobilization therapy is a soft-tissue technique that originated in and is classified within the framework of OMT, and is rarely practised as a stand-alone technique (Ward 2002; Parsons & Marcer 2005; Orrock 2009). Clinical studies that utilize OMT typically encompass multiple manual therapy techniques, which may include, but are rarely limited to, VMT. This lack of homogeneity between published studies means that evaluating the clinical evidence is challenging. Like other forms of manual therapy, VMT requires a body of research to help practitioners take an evidence-informed approach to their clinical practice. Unfortunately, as an isolated technique, it has received very little attention from researchers, and the majority of information is either found in books or provided by clinical training (McSweeney *et al.* 2012; Panagopoulos *et al.* 2013).

Review of embryology

In order to gain a better understanding of the functional anatomy of the connective tissue system, we must briefly review embryology. Starting in the third week of life, the process of embryogenesis gives way to the three-layered embryonic disc, which consists of the ectoderm, endoderm and mesoderm. Every cell and structure in the body is derived from one of these three primitive layers.

When studying the fascia, an emphasis is placed on the mesoderm. This central layer is the progenitor for all of the connective tissues, as well as the striated and smooth muscle, bone, cartilage, pericardium, peritonea, kidneys, gonads, and the muscular walls of the visceral organs and circulatory system vessels. The mesoderm further divides into the somatic and splanchnic layers (Fig. 3). The somatic mesoderm gives rise to the MSK structures of the abdominal canister, which include the transversalis fascia and the parietal peritoneum. The splanchnic layer forms the muscular walls of the visceral structures, i.e. the fascia that supports the organs along with their peritoneal covering. Therefore, both the connective tissues of the MSK system and the visceral structures are contiguous as a result of their origins in a single layer of the triploblast (Paoletti 2006).

The ectoderm, which is the outermost of the germ layers, gives rise to the epidermis, the vast array of nerves acting within the connective tissue, and contributes to the sensory organs (i.e. the eyes, ears and nose). Not only the external covering of the body, but each and every neural structure within it has its origins in the ectoderm, including the central, peripheral and enteric nervous systems. Notably for the purposes of the

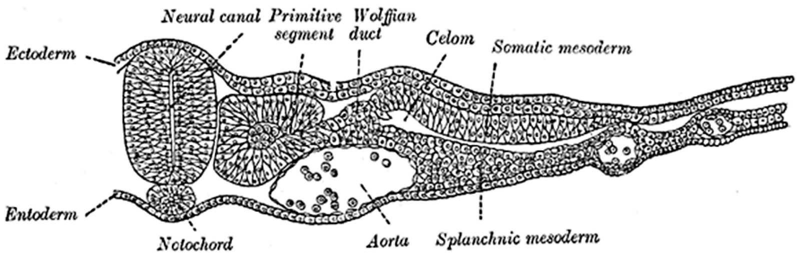

Figure 3. View of the intermediate mesoderm demonstrating the three layers of embryogenesis (illustration: Gray 1918, Fig. 19, p. 52).

present discussion, this includes the neural network of mechanoreceptors found within the fascia and the free nerve endings within the epidermis (Bordoni & Zanier 2014).

Anatomy of the fascial system

In 2007, fascia was defined by the First International Fascia Research Congress as: "the soft tissue component of the connective tissue system that permeates the human body forming a whole body continuous three dimensional matrix of structural support" (Findley *et al.* 2012, p. 67).

Fascia is the ubiquitous connective tissue that is inseparable from all the structures within the body. Its anatomical continuum forms an interconnected functional network within the body (Schleip *et al.* 2012), and it functions as a large, body-wide mechanosensitive signalling network (Langevin 2006). As clinicians, we must move beyond the simplified concept of the myofascia, and realize that the MSK system does not exist in a vacuum. Fascia refers to the packing material that envelops every muscle, bone, gland and cell in the body, including the tissue that surrounds the nervous system, the circulatory vessels and all of the organs (Robertson 2001; Langevin & Huijing 2009). It forms a continuous network throughout the entire body, and plays an important role in transmitting mechanical forces between these structures (Hedley 2010; Kumka & Bonar 2012). The fascia of all layers is highly innervated with nociceptors and mechanoreceptors, which provide information to both the somatic and autonomic nervous systems (Schleip 2003a, b; Bordoni & Zanier 2014). The fascia contains smooth muscle fibres within the cellular structure of the myofibroblast, and this is capable of altering its shape in response to mechanical stimuli (Yahia *et al.* 1993; Langevin *et al.* 2005; Schleip *et al.* 2005).With the inclusion of the structures listed above by the International Fascia Research Congress, the definition of fascia needed to be revised after the earlier concepts of "deep" and "superficial" were updated. Willard (2012a, b) described the fascial system as being divided into four primary layers that are arranged as a series of concentric tubes:

(1) The outermost is called the pannicular or subcutaneous layer, which is found within the adipose tissue that surrounds the entire body.
(2) The axial or investing fascial layer has a direct connection to the panniculus. This more supportive tissue covers the entire trunk, and extends deep into the locomotor system.
(3) The meningeal or dural fascial layer surrounds the nervous system.
(4) The innermost layer, which is the main focus of the present paper, is the visceral fascia. This connective tissue makes up the lining of the thoracic, peritoneal and pelvic body cavities. Visceral "ligaments" function not only as supporting structures, but also as conduits between the vascular, lymphatic and neural structures and the organs. The visceral fascia is by far the most complex of all the fascial layers. From its origin in the naso-oropharyngeal region at the base of the cranium, it follows the path of the visceral column in the neck, forms the mediastinum and central supporting structures of the alimentary canal, and terminates in the pelvic floor at the anal aperture.

Visceral fascia in relation to the somatic frame

There is a consistent presentation of the visceral fascia within the pleural, peritoneal and pelvic cavities. It can be categorized as:

(1) an outer fibrous layer that blends with the muscular canister;
(2) structural "ligaments" that provide support, and serve as a conduit for the neural and vascular elements that supply the organ;
(3) a visceral serous layer that covers the organ;
(4) and a parietal serous layer that lines the cavity (Hedley 2010).

Table 2. Movement of visceral structures in response to activity of the autonomic and somatic nervous systems

Organ	Autonomic activity	Somatic activity
Lung	Sliding of the pleural layers over each other for respiration	Sliding of the pleural layers during thoracic movement
Liver	Deflected inferiorly by 3 cm with each respiration	Rolls over the top of the right kidney with trunk flexion and rotation
Small intestine	Motility for the processes of digestion and elimination	Glides via the visceral and parietal peritoneum during all trunk motion, especially extension
Bladder	Expands into the abdominal cavity, displacing the contents as it fills	The small intestine moves over the top of the bladder and uterus during trunk flexion
Uterus	Descends as much as 3 cm in the pelvis in preparation for menses	Mobility for vaginal canal expansion during intercourse

These serous membranes allow the structures to slide and glide in response to the activity of both the autonomic and somatic nervous systems (Table 2).

As previously stated, the visceral fascia extends from the base of the cranium down to the pelvic floor (Willard 2012b). There are a myriad of attachments to the MSK system along this course, and some of the more significant structures involved are highlighted below.

In the most superior aspect, the visceral column lies directly anterior to the cervical spine, and its layers form the pre-tracheal, retropharyngeal and alar fascia. These compartmentalize the vascular, visceral and muscular structures of the neck, bridging between and attaching to these compartments. Moving inferiorly, the pleurovertebral and costopleural ligaments extend from the dome of the lung, and attach to the vertebrae and first rib, respectively. In the pleural cavity, the endothoracic fascia lines the entire structure, attaching to the internal surface of the ribs and intercostal muscles. Centrally, the mediastinum inserts into the anterior vertebral bodies, posterior sternum and superior aspect of the diaphragm (Paoletti 2006; Breul 2012; Bordoni & Zanier 2013).

Within the peritoneal cavity, the fascia of the oesophagus and aorta pass through the diaphragm, and continue into the midline of the abdominal cavity. The outer fibrous layer is now deemed to be the endoabdominal fascia posteriorly and the transversalis fascia anteriorly. This lining forms the outermost connection between the parietal peritoneum and the muscles, which include the psoas major, iliacus, quadratus lumborum and transversus abdominis. The midline visceral fascia forms a covering over all of the central digestive structures, giving rise to the visceral peritoneum, which divides the abdominal region into the intra- and retroperitoneal spaces. The visceral peritoneum covers the liver, and forms the fascial attachment that suspends the liver from the inferior aspect of the diaphragm. Furthermore, it surrounds the small intestine, and forms the mesentery that attaches to the posterior aspect of the abdominal wall. The visceral peritoneum also serves as a covering for the colon, blending into the axial fascia at the anterior aspect of the quadratus lumborum and iliacus muscles (Fig. 4).

Posteriorly, the endoabdominal fascia thickens significantly, forming a substantial central network that is analogous to the mediastinum. This increase in density supports the great vessels and renal structures, and blends with the investing fascia of the psoas and quadratus lumborum muscles as well as the anterior vertebral bodies. The perirenal fascia is a connective tissue sheath with anterior and posterior layers that enclose the kidneys and adrenal glands. Superiorly, these layers reach as high as the diaphragm, forming a central bridge that covers the renal vessels, and fuse centrally, attaching to the crus. Inferiorly, the fascia encompasses the periurethral fascia to the level of the iliac fossa. The posterior renal fascia attaches to the fascia of the diaphragm, and the quadratus lumborum and psoas major muscles (Fig. 5) (Standring 2005; Willard 2012a).

The endoabdominal fascia extends into the pelvic basin, and continues as the endopelvic fascia. The latter provides an outer layer that surrounds the pelvic cavity, and blends into the axial fascia of the levator ani, coccygeus, piriformis and obturator internus muscles. At the level of the sacral promontory, the visceral midline fascia once again, much like the mediastinum, creates a midline fold that surrounds the hypogastric plexus, pelvic vessels, rectum, reproductive organs and urinary bladder, attaching into the bony pelvis anteriorly and laterally. The uterosacral ligament is a component of this complex that supports the uterus and attaches

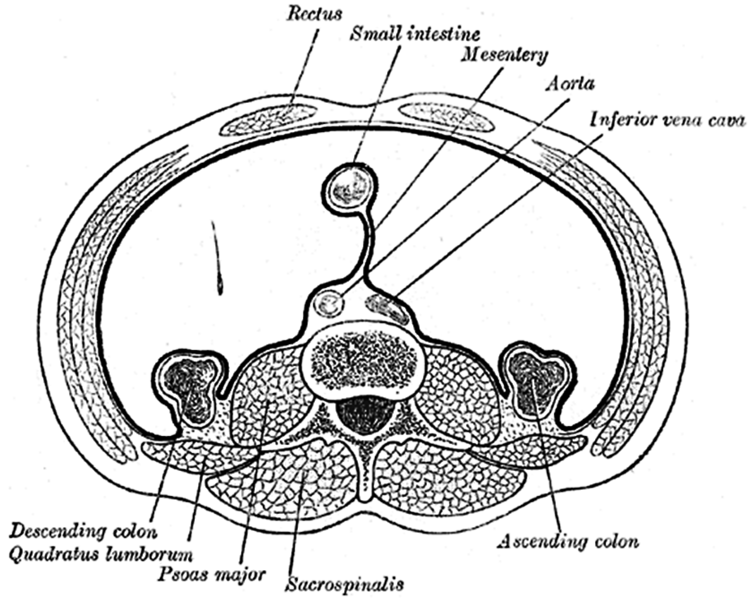

Figure 4. The parietal peritoneum lining the body wall, in direct connection with the transversalis fascia and psoas major, posteriorly forming the mesentery, transitioning into the visceral peritoneum (illustration: Gray 1918, Fig. 1038, p. 1154).

vertically to the anterior body of the sacrum. The transverse cervical ligament is the lateral attachment of the uterus, and this attaches to the lateral pelvic basin. The pubovesical ligaments attach and support the body of the urinary bladder. These extend superiorly as the median and medial umbilical ligaments, and inferiorly, blend with the axial fascia of the pelvic dia-

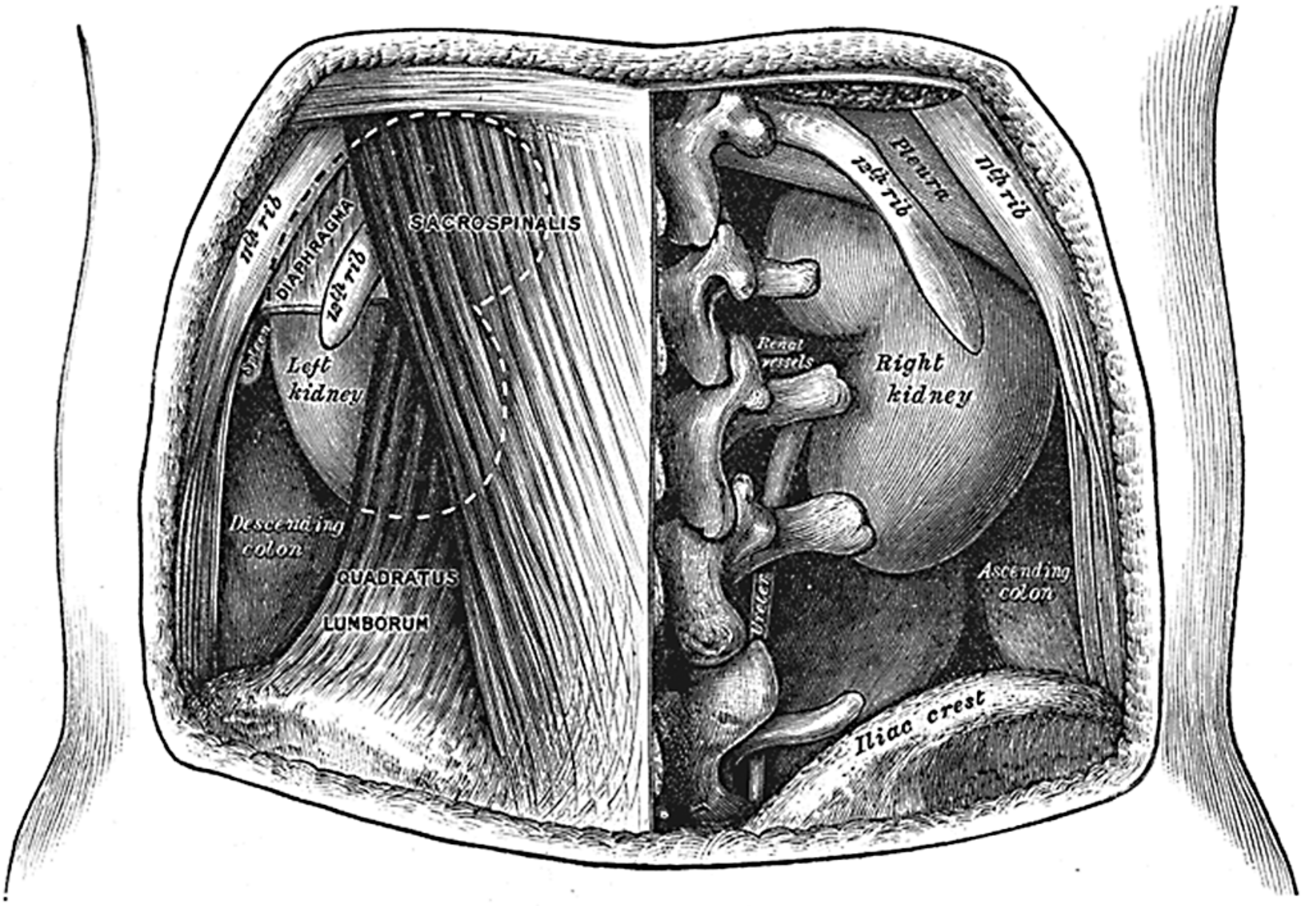

Figure 5. Orientation of the kidneys in the posterior body wall; note the relationships with the diaphragm, psoas and quadratus lumborum (illustration: Gray 1918, Fig. 1124, p. 1219).

phragm. The ischiorectal fossa is inferior to the pelvic diaphragm, and this space is packed with pannicular fascia and contains the anal canal (Barral & Mercier 1988; Barral 1993; Paoletti 2006; Otcenasek *et al.* 2008; Willard 2012a).

Clinical application of manual therapy

Since the inception of physiotherapy, the manual manipulation of tissues has been a primary practice within the profession. Manual therapy is a generic therapeutic modality involving the hands-on treatment of a structural anomaly, and it encompasses a variety of techniques that can be subdivided into either soft-tissue- or joint-based approaches. Although the majority of manual therapy research has been on the MSK system, its effects are not exclusive to any particular region of the anatomy.

The Orthopaedic Section of the American Physical Therapy Association defines the technique of mobilization as ‘‘the act of imparting movement, actively or passively, to a joint or soft tissue’’ (Farrell & Jensen 1992, p. 844). Visceral mobilization therapy is an approach that focuses on mobilizing the fascial layer of the visceral system with respect to the somatic frame, and therefore, it falls under the classification of soft-tissue-based manual therapies. There are higher levels of evidence to support the use of soft-tissue- and/or fascial-based manual therapy to treat MSK pain and dysfunction (Gay *et al.* 2013; Ajimsha *et al.* 2015). Although many models have been proposed, the specific mechanisms behind the response of the MSK system to manual interventions are still not fully understood (Bialosky *et al.* 2009; Clark *et al.* 2012).

The previous model of manual therapy directly relieving local tissue provocation has given way to a new paradigm. It is now recognized that the clinical improvement observed after treatment is not simply a result of the practitioner directly altering the structure beneath their hands through mechanical means. Instead, it is brought about by a combination of afferent input influencing the neurophysiological output and changes in the endogenous cannabinoid system, and even a placebo response evoked simply because of touch (McPartland 2008; Bialosky *et al.* 2009; Gay *et al.* 2014).

Review of the evidence in support of visceral mobilization therapy

The osteopathic literature contains an abundance of clinical trials that include the treatment of visceral pathology. For the purposes of the present paper, this literature review will be limited to those diagnoses most often encountered by practitioners treating pelvic dysfunction.

Musculoskeletal pain states

In a randomized controlled trial (RCT), Tozzi *et al.* (2012) used abdominal ultrasound imaging to measure the kidney mobility in a comparison of 101 asymptomatic patients with 140 participants with low back pain (LBP). Their findings demonstrated that there was reduced kidney mobility with respiration in the LBP group. The symptomatic cohort was then randomized into control and treatment groups, who received either touch-only sham treatment or osteopathic fascial mobilization to the kidney region. Subjective symptoms were measured before and 3 days after treatment with the short form of the McGill Pain Questionnaire. Objective measurements of kidney mobility were taken by a blinded researcher before and immediately after treatment. The results demonstrated that the participants with non-specific LBP had a reduction in kidney mobility compared to the asymptomatic individuals. Visceral mobilization therapy was shown to improve kidney mobility in individuals who underwent treatment, and this progress was accompanied by a reduction in pain complaints over a short-term period.

McSweeney *et al.* (2012) used a single-blinded RCT to investigate the immediate effects of VMT for the sigmoid colon on pressure-pain threshold (PPT) at the L1 paraspinal and the first dorsal interossei. In this study, 15 asymptomatic subjects served as their own controls for repeated measures following VMT, touch-only sham or no-touch interventions. The results demonstrated that there was a statistically significant improvement in PPT at the L1 paraspinal musculature only immediately after VMT intervention. This provides experimental evidence that VMT can produce hypoalgesia in somatic structures segmentally related to the organ being treated.

Lalonde (2014) published a case report about a 51-year-old female who presented with persistent gluteal pain after running a half marathon. Her chief complaint was an inability to run without pain. Her symptoms had not responded to 4 weeks of traditional physiotherapy interventions, i.e. muscle stretching and strengthening. The subject was subsequently referred for osteopathic evaluation. The initial OMT treatment addressed the muscular and articular dysfunctions of her pelvic girdle and hip. One week later, at her second session of OMT, there had been no change in the symptomology. The focus of the treatment was changed to her kidney and its articulating structures. The subject returned one week later, and reported that she was now running 15 km without pain.

Lewit & Olsanska (2004) presented a case series of 51 patients with a variety of MSK complaints that predominantly involved spinal pain. All of the participants had surgical scars on the abdomen, chest and perineum. Soft-tissue-based manual therapy was utilized to treat the scar tissue and the underlying structures. In over two-thirds of cases, this provided significant pain relief after a single session. In 13 cases, the scar treatment contributed to symptom alleviation, and in three, the scar was deemed irrelevant to the patient's treatment.

Rice *et al.* (2013) published a case series that was limited to two patients who experienced chronic abdominal pain as a result of small bowel obstruction (SBO). One subject had undergone seven abdominal surgeries for adhesion-related pain, and radiography showed that the other had SBO. Both individuals underwent an exhaustive 14-h series of manual therapy treatments to the abdomen over a 5-day period. The subjects reported a 90% reduction in pain, further surgeries were rendered unnecessary, and at 1-year follow-up, radiography demonstrated a reduction in SBO in comparison to pre-treatment X-rays.

Chronic constipation

Ernst (1999) and Sinclair (2011) undertook two separate systematic reviews to evaluate the effectiveness of "abdominal massage" for the treatment of chronic constipation in an adult population. However, the studies that met the inclusion criteria had inconsistent methodologies, only a limited number involved control groups and case studies were also included. Nevertheless, both systematic reviews demonstrated that manual therapy was an effective treatment for chronic constipation. A drawback that was noted was that this form of treatment needed to be performed repeatedly to ensure lasting results.

Tarsuslu *et al.* (2009) compared two interventions in a unique population, i.e. children with cerebral palsy and chronic constipation. Both groups were treated with osteopathy, which included VMT, but only one received additional standard medical treatment. The Constipation Assessment Scale was used to determine the participants' responses to treatment, and this measure demonstrated similar positive outcomes in both groups at 3- and 6-month follow-ups. The results of this study suggest that manual therapy alone is as effective as manual therapy plus medical intervention. The small sample size of this feasibility study limits its clinical impact.

McClurg *et al.* (2011) completed a feasibility study comparing bowel management alone with bowel management and abdominal massage for patients with multiple sclerosis and chronic constipation. The intervention was carried out over a period of 4 weeks with a 4-week follow-up. Patients in the treatment group, or their care providers, were instructed in a specific abdominal massage protocol that was to be performed daily. Validated outcome measures were scored at the beginning of the study, and at weeks 4 and 8. Data analysis suggested that the intervention had a positive effect. A multicentre trial for chronic constipation in patients with multiple sclerosis is currently underway in the UK.

Irritable bowel syndrome

Müller *et al.* (2014) completed a systematic review of controlled trials utilizing OMT for the treatment of irritable bowel syndrome. As previously stated, OMT is the therapeutic application of manually guided forces, and involves a variety of techniques, including VMT, that are intended to improve physiological function. No specific standardized treatment protocol was listed in Müller *et al.*'s (2014) review because all the studies included allowed therapy to be individualized according to the judgement of the treating osteopath. Visceral mobilization therapy was one of the primary treatment modalities utilized in the various trials, and the information contained in this review is encouraging, although limited by the small number of studies available and the lack of standardization of care.

Lower urinary tract symptoms

Franke & Hoesele (2013) completed a systematic review and meta-analysis of the literature on RCTs and controlled clinical studies utilizing OMT for the treatment of lower urinary tract symptoms in adult females. The studies that met the inclusion criteria focused on the treatment of voiding dysfunction, overactive bladder, and stress and urge urinary incontinence. The quantitative analysis demonstrated that there was a statistically significant and clinically relevant improvement when OMT intervention was compared with untreated controls. Of the tissues targeted in the various studies, the visceral structures around the bladder received substantial attention, as did the somatic pelvis. It should be noted that the reference treatment in two of the studies was PFM training by physiotherapists, and this produced a very similar therapeutic outcome to OMT. The same limitations exist with regard to the interpretation of this data as were noted for the review by Müller *et al.* (2014), i.e. only a small number of studies were available and there was a lack of standardization of care. The conclusion drawn by Franke & Hoesele (2013) may be more relevant to the general application of manual therapy for the treatment of urinary dysfunction than VMT alone.

Nemett *et al.* (2008) investigated the application of manual physical therapy based on an osteopathic approach (MPT-OA) for the treatment of paediatric voiding dysfunction in conjunction with standard therapy compared to standard therapy alone. Because of the population involved, this study was not included in the above-mentioned systematic review by Franke & Hoesele (2013). The children enrolled had been under the care of a paediatric urologist for more than 6 months without adequate symptom resolution. All the participants had diagnoses of detrusor instability and/or vesicoureteral reflux. The evaluation of the treatment group included a detailed analysis of postural alignment, and documentation of somatic dysfunction that included specific details of the mobility of the viscera. Both groups continued to undergo standard treatment at the paediatric urology clinic. The treatment group had the addition of four, 1-h sessions of MPT-OA, which particularly focused on the thoracolumbar spine, thoracic and pelvic diaphragms, pelvis, and pelvic organs. These participants exhibited greater improvements in their symptoms of daytime enuresis, vesicoureteral reflux and post-void residual urine volume than the control group. Several of these parameters neared statistical significance; however, the small sample size ($n=21$) did not provide sufficient data.

Infertility

Kramp (2012) published a case series in which multiple manual physical therapy (MPT) techniques, including VMT, were employed with the goal of mobilizing restricted tissue and draining the congested lymphatics of the reproductive system. Ten women diagnosed with either primary or secondary infertility underwent between one and six treatment sessions involving a standardized MPT protocol, and were followed up after 3 months. Treatment was discontinued if the subjects had positive pregnancy tests, or the identified tissue restrictions were resolved. Six of the 10 subjects (60%) conceived within the 3-month period, and then delivered at full term. In the absence of a control group, a comparison was made with the normal fecundity rates of fertile couples, which were reported to be 57% in the same time period. It should be noted that five of the subjects in this study had unsuccessfully undergone previous infertility treatment at substantial cost. The limitations of this case series were the small sample size and the lack of control group. However, M. E. Kramp is currently working with the present author on the Mechanical Infertility Systematic Study. Currently in the feasibility stage, this is a protocol-driven crossover design comparing MPT with global massage therapy as a control.

Rice *et al.* (2015) conducted a 10-year retrospective review of 1392 patients who were treated with an MPT protocol in order to address underlying adhesive disease leading to infertility. The diagnoses of these individuals, who were treated in a private physiotherapy clinic, included tubal occlusion, hormonal dysfunction and endometriosis. Some patients were undergoing concurrent *in vitro* fertilization at the time of treatment. The protocol of 40 h of MPT delivered over a 5-day period focused on restoring mobility to the structures affecting reproductive function. Of greatest interest to the MPT practitioner is the treatment of tubal patency, which is responsible for 25–35% of female infertility. For the purposes of this study, fallopian tubes were initially confirmed as occluded either surgically or with a hysterosalpingogram (HSG). In the follow-up group, successful patency of at least one tube was confirmed by repeat HSG or successful intrauterine pregnancy. Because the standard of care for tubal occlusion is surgical intervention, which achieves only varying degrees of success and involves substantial costs, MPT has great potential as a conservative option. Patients who had undergone no previous surgical attempts to clear tubal occlusion had a reported success rate of 69%, while those with a history of previous surgery to open blocked tubes had a much lower success rate of 35%. The finding of superior success rates in non-surgical patients is clearly significant. Unfortunately, less than 35% of patients treated presented for a follow-up evaluation, and therefore, these overall success rates offer little in the way of high-quality statistical information. The low number of individuals who took part in a long-term follow-up and the lack of a control group make this 10-year retrospective study helpful but deficient.

Adverse effects

Any review of the literature would not be complete without a discussion of the deleterious effects of treatment. Grant (2003) evaluated reports of significant injuries related to the practice of therapeutic massage that were cited in the literature from 1965 to 2003. The greatest category of common injury reported was eight cases of extracranial vertebral artery dissection (Pego *et al.* 1996, cited in Grant 2003). There were also three case reports of visceral injury caused by massage. A paper by Rahman *et al.* (1987, cited in Grant 2003) described the case of a patient in Malaysia who experienced a sigmoid colon perforation that was related to deep-tissue massage of the abdomen. Another case report discussed a healthy 39-year-old female who developed a hepatic haematoma following deep-body massage that included the right upper abdomen (Trotter 1999, cited in Grant 2003). A paper by Kerr (1997, cited in Grant 2003) documented the case of a patient who suffered the displacement of a ureteral stent while undergoing the Rolfing method, a particularly forceful massage technique. It should be noted that virtually all VMT training directly contraindicates working on an area of the body that contains foreign objects or implanted medical devices. Ernst (2003) performed a similar review of the literature that included the above adverse events related to visceral treatment plus one additional case (Thambu 1971, cited in Ernst 2003): a Malay surgeon reported the surgical repair of the ruptured uterus of a 30-year-old woman after she received massage to the abdomen for pregnancy issues from a traditional healer.

Conclusion

There is sound biological plausibility to support VMT, which is practised across multiple disciplines in a number of countries. However, the current evidence is limited by the small number of controlled clinical trials that have been conducted in this field. Nevertheless, there is significant clinical evidence that conditions such as somatic pelvic pain, and bowel, bladder and reproductive system dysfunction may be the result of referred visceral pain, central sensitization and restrictions in visceral tissue mobility, which may further contribute to dysfunction within the canister of core musculature. The MSK framework is a mysterious, perplexing and complicated system. However, it is unique in that it offers manual therapists a variety of tissues and techniques from which to choose in order to treat their patients. Science has acknowledged that the visceral structures and their connective tissue attachments have an influence on the function of the somatic frame. The question is: can we manually manipulate these structures and bring about an effect with a reasonable degree of specificity while producing a therapeutic outcome?

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