FROM TISSUE TO CENTRAL NERVOUS SYSTEM THROUGH AUTONOMIC NERVOUS SYSTEM

Viscero-somatic Reflexes and Manual Medicine Research

Hollis H. King, DO, PhD, FAAO
April 9, 2011
OMT generally accepted for treatment of musculoskeletal disorders

Figure 3
Meta-analysis results for osteopathic manipulative treatment (OMT) of low back pain. The overall effect size was -0.30 (95% confidence interval [CI], -0.47 – -0.13; P = .001). Source citations are available in reference 5.
Overview of Presentation

1. Some history of Somato-visceral interactions
2. Early development of concepts
3. Research and current status
4. Clinical applications
Sushruta (Around 600 BCE) was an ancient Indian surgeon and is the author of the book *Sushruta Samhita*, in which he describes over 300 surgical procedures and 120 surgical instruments and classifies human surgery in 8 categories.

Sushruta also described “Hritshoola,” which literally means “heart pain,” perceived as somatic pain.*

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Osteopathic Medicine and manual therapy are poised to become a force for good and health in the world.

Osteopathic Medicine and manual therapy is an idea whose time has come.

Contemporary man tends to look outside of himself for the answers to health and well being (science). Osteopathic philosophy holds that the answers have been inside of us all along. A person just needs a knowing and caring touch – OMT or manual therapy – to achieve greater health.
“Somato-Visceral Interactions and Autonomic Mechanisms of Manual Therapy” follows in a line of related conferences.
International Interdisciplinary Symposium

Somato-Visceral Interactions and Autonomic Mechanisms of Manual Therapy

Osteopathic Medicine, Somato-Visceral Interactions and Clinical Research – Ready for Prime Time?

March 31, 2008

Hollis H. King, DO, PhD
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THE SCIENCE AND CLINICAL APPLICATION OF MANUAL THERAPY


This book makes a powerful case for how MT/MM affects the central nervous system and the autonomic effector systems (the circulatory, respiratory, gastrointestinal systems, and pelvic organs) which impact on a person’s health. It covers how MT/MM works and details the conditions – such as chronic skeletal and visceral pain diseases, asthma, pneumonia, and cardiovascular dysregulation – that can benefit from it. Longstanding theoretical models of MT/MM mechanisms are critically assessed in the light of current understanding of physiological and neurophysiological function, and the influences of psychological and cortical processes on the effects of MT/MM are explored.

The book consists of four main sections:

- Peripheral and spinal-viscero-somatic mechanisms.
- Supraspinal mechanisms (including those of the forebrain).
- Clinical applications of MT/MM.
- Critical assessment of the impact of research in basic and clinical science on clinical practice and research funding.

The book will appeal to osteopathic physicians, chiropractors, physical therapists and massage therapists, as well as all body workers/health practitioners who use their hands in health care. It will appeal to all practitioners involved in treatment of chronic pain disorders as well as those involved in basic and clinical research in this field.
Viscero-Somatic Interactions
Long a part of osteopathic research and clinical consideration

The Journal
OF
The American Osteopathic Association

Vol. 7.
Auburn, N. Y., October 1, 1907.
No. 2.

VISCERO-SOMATIC AND SOMATO-VISCERAL SPINAL REFLEXES.

Louisa Burns, M. S., D. Sc. O.
Department of Physiology, Los Angeles,

Results to be Attained.

In the study of the physiology of the sympathetic nervous system it was noted that a lack of clearness was especially evident concerning the locality in which the viscero-sensory impulses affect the viscero-motor nerves. It occurred to me that a study of viscero-somatic and somato-visceral spinal reflexes might assist in determining whether this co-ordination takes place chiefly in the sympathetic ganglia, or chiefly in the spinal cord. It is evident that viscero-somatic reflexes would be impossible if viscero-sensory nerves did not
In dogs and cats, “For the experiments upon the abdominal viscera, the abdominal wall was cut, and the viscera exposed to view with as little manipulation as possible. The stimulation of the inner wall, the muscular coat and the peritoneal covering of the cardiac end of the stomach or of the fundus was followed by the contraction of the spinal muscles near the sixth to the ninth thoracic vertebrae.” p. 54
“The stimulation of the tissues near the fifth to the eighth thoracic vertebrae was followed by muscular and secretory activity in the stomach, and stimulation near the eighth to the twelfth thoracic vertebrae was followed by activity of the intestines.” p. 55
Wilbur Cole, DO and others continued Burns’ work.
Rabbits: 5 experimental (had T10-L1 “immobilized with wire bilaterally on the transverse processes”), 3 controls. Sacrificed after 4 months. Histological sections of organs made. In the experimental rabbits the kidney the glomeruli were swollen, as were the cells of the collecting tubules of the cortex compared to controls.
"By 1947, the work of Denslow and Korr\textsuperscript{1-3} was providing new insights into the palpable findings at a lesioned segment. In comparison to other segments, the lesioned segment was a spinal location of significantly lowered reflex thresholds.”

Michael Patterson, Sted Denslow, Irvin Korr
Korr IM. The spinal cord as organizer of disease processes: the peripheral autonomic nervous system. JAOA 1979;79:82-90.

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Fig 1. Diagrammatic view of brainstem and spinal cord, representing origins of the ANS; that is, the location of the cells of origin (preganglionic neurons) in the central nervous system. These neurons are subject to a vast variety of presynaptic influences. In this and in all the diagrams the sympathetic division is in the center and the parasympathetic is at the top and bottom. Roman numerals represent parasympathetic cranial nuclei. Arabic numerals indicate cervical, thoracic, lumbar, and sacral segments of the spinal cord, and the segmental origins (intermediolateral cell columns) of the sympathetic division (T1 to L2), and the sacral portion of the parasympathetic division (S2 to S4). Fig 2. Paravertebral chains of sympathetic ganglia and the preganglionic fibers (leaving the spinal cord via the ventral roots and white rami between T1 and L2). Encircled pairs or groups of ganglia indicate fusions that are commonly found. Fig. 3. Visceral structures are represented within the human figure in four main groupings: those of head and neck; thoracic; abdominal; pelvic and genital. Only the parasympathetic innervation is shown. In this and the remaining figures solid lines represent preganglionic axons and interrupted lines represent postganglionic axons.
Viscerosomatic Reflexes

- Autonomic Nervous System (ANS) is an efferent system.
- Visceral afferents: carry impulses from the organ to the cord.
- Usually uses the same pathways as that organ’s sympathetic innervation, and synapse in spinal cord at the level of sympathetic innervation.
When a Viscero-somatic Reflex
Turns into a Facilitated Segment

T 3-4 dermatome “Hritshoola”

Foundations for Osteopathic Medicine 3rd ed. P.124
VisceroSomatic Reflexes - Acute

1. Changes palpated most readily at the costo-transverse area.
2. Vasomotor reaction with an increase in skin temperature.
3. Sudomotor effect with increased moisture in area.
5. Red reflex.
6. Increased subcutaneous fluid.
7. Increased muscle contraction, especially deep muscles.
8. On motion testing, barrier may feel like a "hard rubber band" which does not resolve with treatment.
9. The reactivity is greater in patients who are in pain from organic disease.
Viscero-Somatic Reflex - Chronic

1. Trophic changes in the skin.
2. Increased thickening of skin and subcutaneous tissues.
3. Localized muscle contraction with the deep muscles involving two or more segments, and tending to involve more segments than the acute reflex.
4. On motion testing, may feel like a hard barrier.
Referred Visceral Pain
Organ Specific

- Visceral peritoneum is innervated by autonomic afferent nerves & poorly localized, sometimes being referred to distant locations
“Spinothalamic system and viscerosomatic motor reflexes: functional organization of cardiac and somatic input”
Robert D. Foreman • Chao Qin • Chuan-Chau Jerry Jou

in King, Jänig, Patterson 2011

Make the scientific case for the mechanisms underlying the long held idea of viscerosomatic interactions.

Figure 7.1 Diagrams of the general area of referred pain (A) and change in the tonicity of paraspinal muscles (B) resulting from patients experiencing angina pectoris. In B palpatory techniques were used in patients with ischemic heart disease to determine changes in paraspinal muscles. The abscissa is the number of cases and the ordinate is the spinal segment level from cervical segment 1 (C1) to thoracic segment 12 (T12). The arrows from the graph to the human figure indicate the location of the equivalent segments. B is adapted from Beal (1985).
Spinal Facilitation

1. The maintenance of a pool of neurons (e.g. premotor neurons, motor neurons or preganglionic sympathetic neurons in one or more segments of the spinal cord) in a state of partial or subthreshold excitation; in this state, less afferent stimulation is required to trigger the discharge impulses.

2. Facilitation may be due to sustained increase in afferent input, or changes within the affected neurons themselves or their chemical environment. Once established, facilitation can be sustained by normal central nervous system (CNS) activity.
In fact, this is what we teach in USA OPP classes.

Attempt to standardize sympathetic nervous system with regard to organ innervation.
Viscero-visceral reflex

- Viscero – visceral reflex
  - “localized visceral stimuli producing patterns of reflex response in segmentally related visceral structures”
  - Example: food in the gut stimulates peristalsis
    - Guyton: Medical physiology
  - Distension of the distal colon will inhibit motor activity of the proximal colon.
Are there enough neurons in the dorsal root ganglion to account for this activity? Comment by Dr. Jänig to me.
Somato-Somatic

• Somato – somatic reflex
  – “localized somatic stimuli producing patterns of reflex response in segmentally related somatic structures”

• Patellar reflex
  – Testing the integrity of the monosynaptic arc at L2-L4. Sensory input at patellar ligament reflex contraction of the quadriceps.
Monosynaptic reflex for Somato-somatic reflex
Important animal research


Cited and illustrated in chapter by Pickar JG et al. Somatosympathetic reflex mechanisms. In King, Jänig, Patterson 2011.

**Figure 3.1** Schematic of the experiment used by Sato and Swenson (1984) to study somatosympathetic reflexes in the chick rat.

**Figure 3.2** Changes in mean renal and adrenal sympathetic nerve discharge (SND) activity during lateral bending movement of thoracic or lumbar vertebrae. SND was quantified by threshold crossings of the electrical activity. Crossings were counted as impulses and placed into 5-second bins, each bin being identified by a symbol. (Redrawn from data in Sato and Swenson (1984).)
Major question is whether or not OMT or any manual medicine/manual therapy can impact a visceral process or systemic disorder?

**Conclusions**

1. The hypertensive patients underwent a significant, reproducible decrease in serum aldosterone levels after OMT.
2. During the period of the investigation no significant alterations of systemic blood pressure were demonstrated.
Fig. 1. Change in serum aldosterone levels of normotensive subjects after manipulative (OMT) and sham treatments. (I = SEM)

Fig. 2. Serum aldosterone levels in normotensive subjects after manipulative (OMT) and sham treatments. (I = SEM)

Fig. 3. Change in serum aldosterone levels of hypertensive subjects after manipulative (OMT) and sham treatments. (I = SEM)

Fig. 4. Serum aldosterone levels of hypertensive subjects after manipulative (OMT) and sham treatments. (I = SEM)
Can OPP/OMT Affect Physiologic Function?

Blood Glucose Levels
Blood Glucose Levels

Osteopathic Medicine and Primary Care

Editorial

Rediscovering the classic osteopathic literature to advance contemporary patient-oriented research: A new look at diabetes mellitus

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This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.
Bandeen SG. Panceatic stimulation and blood chemical changes.

American Academy of Osteopathy Yearbook. 1948

N=40 non-diabetic pts.

T12 – L1 stimulation
Fig. 5. Blood glucose measures before and after pancreatic inhibition in apparently non-diabetic patients. Data are from 40 patients, representing 25 years of research published in 1949, and include complete follow-up at 30 and 60 minutes post-inhibition. Adapted from Bandeen.20
Bandeen reported more data in 1949


N = 150

Diabetic and Non-diabetic
Average blood sugar before stimulation 228.2. Average drop in blood sugar observed after 30 min after stimulation 31.3, after 60 min was 58.5. Greatest drop after 30 min 210, after 60 min 118.
A recent study sought to determine whether osteopathic manipulative treatment (OMT) improved outcomes in patients with postoperative ileus. The study, conducted in a central Florida hospital between 2003 and 2006, was a retrospective chart review of patients with postoperative ileus. Of the 331 patients who met inclusion criteria and had undergone abdominal surgery, 172 received OMT and 139 did not. Data analysis revealed that patients who received OMT had statistically significant shorter hospital stays (11.8 vs. 14.6 days; \( P = .029 \)).
A Post-Op Ileus Protocol
From Dr. Crow’s study (Co-author of LAS Book)

1. OA Release & Condylar Decompression (KIM 69C&D)
2. Anterior cervical fascia (KIM 40A, 41D) and LAS (LAS 146)
3. Diaphragm release (KIM 55A)
4. Rib raising (KIM 63E)
5. Direct inhibition of the paraspinal musculature from T6-L5 (KIM 43B)
6. Collateral ganglion release (FOM 760, Channell&Mason 190, WV 340)
7. Mesenteric lifts/releases (FOM 1074)
8. Ilio-Sacral Release (LAS 75)
9. Thoracic lymphatic pump – gently (KIM 61A)
Heart Rate Variability
(HRV)
Giles PD. Effects of cervical manipulation on autonomic control. Unpublished Master’s Thesis University of North Texas Health Science Center, Fort Worth, TX 2006.


With an N=24 in a cross-over design, heart rate variability was best when the OCF was applied compared with sham and time control conditions.
Intervention 1: OMT

- Soft Tissue
  - Kneading
  - Stretching

- Sub-Occipital Decompression
Intervention 2: Sham

- No Soft Tissue Treatment
- Similar Finger Placement
- Light Touch
- Controlling for Human Touch
Intervention 3: Time Control

- No Treatment
- No Contact
- Subject Lay quietly for same amount of time as interventions 1 and 2.
- Controlling for Time of treatment
HRV: Time Domain

SDNN (sec)
OMM in Post-Coronary Artery Bypass Surgery (CABG)
Does OMT help patients after CABG?
Hemodynamic Effects of Osteopathic Manipulative Treatment Immediately After Coronary Artery Bypass Graft Surgery

Albert H. O-Yurvati, Michael S. Carnes, Michael B. Clearfield, Scott T. Stoll, and Walter J. McConathy
J Am Osteopath Assoc 2005 105: 475-481. [Abstract] [Full Text] [PDF]

This study describes the immediate effects of postoperative osteopathic manipulative treatment (OMT) on cardiac hemodynamics after coronary artery bypass graft surgery, while patients remained sedated and pharmacologically paralyzed. Assessments of blood distribution (thoracic impedance), oxygen content of blood (mixed venous oxygen saturation), and cardiac output (cardiac index) all demonstrated the immediate physiologic benefit of OMT. Based on this pilot study, the authors conclude that OMT has immediate, beneficial hemodynamic effects following coronary artery bypass graft surgery.
CABG – Coronary Artery Bypass Graft
Harvesting the LIMA involves lifting and distracting the left half of the rib cage even more than the right.
The rib spreader moves the ribs in an inhalation somatic dysfunction diffusely throughout the thorax.
PATHOPHYSIOLOGY

• Surgeons tend to spread the ribs most in the lower sternal region. The costal margin is more flexible and facilitates spreading.

• Upper ribs tend to break if you move them laterally very much.
Osteopathic Considerations of Treatment

• The idea of treatment:
  – To restore normal motion to the mediastinum while it heals
  – To prevent development of a restrictive scar

• Innervation
  – Parietal pleura is the only pleura with sensory innervation
  – Phrenic nerve innervates abdominal diaphragm

• Mediastinal attachments
  – Diaphragm
  – Pretrachial fascia
  – Anterior cervical fascia
  – Parietal pleura
  – Prevertebral pleura
Osteopathic Treatments (con’t)

• Pedal lymphatic pump
  – Affects intrathoracic/abdominal pressure gradients and facilitates the circulation of lymphatic fluids
• “Redoming” the diaphragm – indirect myofascial release
  – Improves motion of the diaphragm by releasing myofascial tissue tension within structures attached to the diaphragm
  – Stimulates lymphatic fluid circulation, prevents or aids in the correction of atelectasis, and improves chest wall compliance
• Suboccipital decompression
  – Improves parasympathetic function by releasing tightness of the tissue around the vagus nerves, which exit at the base of the skull
• Rib raising
  – Improves movement of the ribs and thoracic cage by mechanically articulating the rib joints
  – Mechanical stimulation of the sympathetic chain ganglia (which are in close proximity to the rib heads) will result in better sympathetic tone within the lung
$SxO_2$ – An indicator of peripheral oxygen consumption.
*P value represents paired t test comparing pre-OMT mean with post-OMT mean.
*P value represents unpaired t test comparing change in mean for OMT group with change in mean for control group.
Thoracic Impedance – An indicator of central blood volume; when central blood volume is reduced, impedance increases due to the current's decreased ability to be transmitted through the tissues. Indicates a change in fluid distribution consistent with a decrease in intrathoracic fluid volume and redistribution to peripheral circulation.
*P value represents paired t test comparing pre-OMT mean with post-OMT mean.
Cardiac Index – An indicator of cardiac function that reveals the amount of blood ejected by the left ventricle into systemic circulation in one minute, divided by the body’s surface area.
Mean Cardiac Index (L/min)

Pre-OMT  
Post-OMT  
(n=10)

*P < .01

*P value represents paired t test comparing pre-OMT mean with post-OMT mean.
Mean Change in Cardiac Index (L/min)

OMT Group (n=10)

Control Group (n=19)

*P < .02

*P value represents unpaired t test comparing change in mean for OMT group with change in mean for control group.
LPT enhances lymph flow

- Knott *et al.* instrumented dogs to record lymphatic flow in the thoracic duct during LPT and found significant increases in lymph flow during LPT.

  *First data to support a mechanism of how LPT may enhance immunity.*

Mean Change in Thoracic Duct Lymph Flow

Fig. 1
Thoracic Pump (+/- SE, n = 4)
Abdominal Pump (+/- SE, n = 4)
Pedal Pump (+/- SE, n = 4)

Thoracic Duct Flow (ml/min)

Mean Change in Thoracic Duct Lymph Flow
Immune System also Enhanced

LPT increases leukocytes in lymph without altering leukocyte populations

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>ALP</th>
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<tr>
<td><strong>Cell Concentrations</strong></td>
<td></td>
<td></td>
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<tr>
<td>(x 10^6 total leukocytes/ml)</td>
<td></td>
<td></td>
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<tr>
<td><strong>Total Leukocytes</strong></td>
<td>4.8</td>
<td>11.8</td>
</tr>
<tr>
<td><strong>Neutrophils</strong></td>
<td>0.31</td>
<td>1.19</td>
</tr>
<tr>
<td><strong>Macrophages</strong></td>
<td>0.27</td>
<td>1.16</td>
</tr>
<tr>
<td><strong>Lymphocytes</strong></td>
<td>3.94</td>
<td>9.41</td>
</tr>
<tr>
<td><strong>T cells</strong></td>
<td>3.55</td>
<td>9.22</td>
</tr>
<tr>
<td><strong>B cells</strong></td>
<td>0.80</td>
<td>2.4</td>
</tr>
<tr>
<td><strong>Percentages</strong></td>
<td></td>
<td></td>
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<tr>
<td><strong>Neutrophils</strong></td>
<td>15.5</td>
<td>16.4</td>
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<tr>
<td><strong>Macrophages</strong></td>
<td>10.7</td>
<td>12.3</td>
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<tr>
<td><strong>Lymphocytes</strong></td>
<td>73.3</td>
<td>70.7</td>
</tr>
<tr>
<td><strong>T cells</strong></td>
<td>74.5</td>
<td>69.7</td>
</tr>
<tr>
<td><strong>B cells</strong></td>
<td>18.4</td>
<td>24.7</td>
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LPT increases leukocyte flux in lymph

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>LPT</th>
</tr>
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<tbody>
<tr>
<td>Total Leukocytes</td>
<td>8.2 ± 4.10</td>
<td>60.0 ± 25.0 *</td>
</tr>
<tr>
<td>Neutrophils</td>
<td>0.15 ± 0.03</td>
<td>3.73 ± 0.58 *</td>
</tr>
<tr>
<td>Macrophages</td>
<td>0.61 ± 0.16</td>
<td>4.86 ± 1.36 *</td>
</tr>
<tr>
<td>Lymphocytes</td>
<td>8.22 ± 0.12</td>
<td>55.2 ± 29.2 *</td>
</tr>
<tr>
<td>T cells</td>
<td>7.24 ± 4.15</td>
<td>51.9 ± 26.5 *</td>
</tr>
<tr>
<td>B cells</td>
<td>1.39 ± 0.75</td>
<td>11.2 ± 3.90 *</td>
</tr>
</tbody>
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Thermographic Examination of Low Back and Abdominal Area Skin Temperatures in Individuals with and without Focal Onset Epilepsy

Study just approved by the A.T. Still University – School of Osteopathic Medicine in Arizona Institutional Review Board (IRB). Collaborating with the Epilepsy Foundation of Florida will have 50 Focal Onset Seizure (ICD9-CM 345.5) compared to 50 matched controls.
Traditional osteopathic concepts acknowledged the cerebral and abdominal brains. Traditional osteopathic perspective on epilepsy was influenced by this view because musculoskeletal somatic dysfunction was also diagnosed in cases of epilepsy (A likely outcome of a viscerosomatic reflex.) Manual therapy was then applied based on the perspective that the abdomen and its nerve plexus were involved in the pathophysiology of certain forms of epilepsy. There are a number reports of success in treating epilepsy this way (e.g., Riggs, 1901; Hazzard, 1905; Murray, 1925).

Riggs WL. (1901) A manual of osteopathic manipulations and treatment. New Science Publishing Co; Des Moines, IA


Two Mechanisms of Actions

1. Autonomic nervous system (ANS), especially sympathetic nervous system (SNS) mediated response. Technically called a viscero-somatic interaction (reflex).

2. Large (cecal and colon) and small (ileum and jejunum) intestinal structures near the surface of abdominal wall in the area (RLQ) described by early osteopaths as having “cold spots.” A biomechanical/structural mechanism.
Dermatome Chart

Areas of the body which would experience circulation, pain, or any physical phenomena if that particular vertebral segment was involved in transmitting a sensory impulse.
TABLE 1

Abdominal thermograms of four cases of epilepsy and four nonepilepsy cases. Note the distinctive cold spot on the right side of the abdomen in the epilepsy patients (circled with white outline).
THANK YOU FOR YOUR KIND ATTENTION
Some Perspective on EBM

In the current era of emphasis on evidence-based practice, it is interesting to note in relation to musculoskeletal disorders that there is no evidence-based research supporting surgery for low back pain (Palmer & Patijn 2009) and that only 13% of all medical practice is considered beneficial with another 23% considered likely to be beneficial (BMJ Clinical Evidence Centre 2009).


[http://clinicalevidence.bmj.com/ceweb/about/knowledge.jsp](http://clinicalevidence.bmj.com/ceweb/about/knowledge.jsp) [http://clinicalevidence.bmj.com/ceweb/about](http://clinicalevidence.bmj.com/ceweb/about)
The Science and Clinical Application of Manual Therapy is a multi-disciplinary, international reference book based on work by the top basic science researchers and clinical researchers in the area of Manual Therapy and Manual Medicine. The first book to bring together research on the benefits of Manual Therapy/Manual Medicine (MT/MM) beyond the known effects on musculoskeletal disorders, it presents evidence of the benefits of MT/MM in treating systemic disorders.

This book makes a powerful case for how MT/MM affects the central nervous system and the autonomic effector systems (the circulatory, respiratory, gastrointestinal systems, and pelvic organs) which impact on a person’s health. It covers how MT/MM works and details the conditions – such as chronic skeletal and visceral pain diseases, asthma, pneumonia, and cardiovascular dysregulation – that can benefit from it. Longstanding theoretical models of MT/MM mechanisms are critically assessed in the light of current understanding of physiological and neurophysiological function, and the influences of psychological and cortical processes on the effects of MT/MM are explored.

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