Viscerosomatic reflexes: A review

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The concept of viscerosomatic reflexes is presented and supporting documentation from the basic and clinical sciences is reviewed. The somatic manifestations of visceral disease, including their autonomic segmental reference sites, are described. Also discussed are the palpatory findings that are consistent with diagnosis of a viscerosomatic reflex, as well as their predictive value. In addition, the principles and results of manipulative treatment for visceral disease, as well as the effect of surgery on viscerosomatic findings, are reviewed.

The osteopathic profession has held certain basic tenets to be true— that altered or impaired function frequently occurs in the somatic system, that these somatic components may be manifest as presymptomatic signs of disease, and that they may be expressed as local or remote effects of dysfunction as somatovisceral or viscerosomatic reflexes.

Although these concepts have been accepted as basic statements of osteopathic philosophy, there is little formal evidence other than anecdotal clinical experience to support them. The incidence of somatic dysfunction in a normal population has not been established. However, several studies[1-5] have reported the incidence of palpatory findings for certain patient populations. There is limited evidence to support the theory that dysfunctional somatic components act as presymptomatic signs of disease.[6] The local and remote effects of somatic dysfunction have been described, and experimental studies have confirmed the existence of somatovisceral and viscerosomatic reflexes.[7] The major emphasis in this paper is the exploration of the relationship of somatic dysfunction to visceral disease.

A viscerosomatic reflex is the resultant of the effect of afferent stimuli arising from a visceral disorder on the somatic tissues. The reflex is initiated by afferent impulses from visceral receptors; these impulses are transmitted to the dorsal horn of the spinal cord, where they synapse with interconnecting neurons. These, in turn, convey the stimulus to sympathetic and peripheral motor efferents, thus resulting in sensory and motor changes in somatic tissues of skeletal muscle, viscera, blood vessels, and skin (Fig. 1.).

Visceral afferents play an important part in the maintenance of internal equilibrium and the related mutual adjustments of visceral function. They are also responsible for the conduction of pain impulses that may be caused by distention of a viscus, anoxia (particularly of muscle), irritating metabolites, stretching or crushing of blood vessels, irritation of the peritoneum, contraction of muscular walls, and distention of the capsule of a solid organ.[8,9] Because pain-sensitive nerve endings are not numerous in viscera, pain sensation or a visceral reflex response may result from the combined input of several different types of receptors rather than as a specific response to a particular receptor. A variety of visceral receptors have been identified[10]: mucosal and epithelial receptors, which respond to mechanical and epithelial stimuli; tension receptors in the visceral muscle layers, which respond to mechanical distention, such as the degree of filling; serosal receptors, which are slow adapting mechanoreceptors in mesentery or serosa and which monitor visceral fullness; pacinian corpuscles in mesentery and pain receptors; and free nerve endings in viscera and blood vessels.

Impulses from visceral receptors travel along afferent nerve fibers that parallel sympathetic efferent nerve fibers arising from the same spinal cord segment and that have a similar distribution to the region or viscus. Visceral afferent nerves are preponderant in respect to efferent nerve fibers; the ratio of afferent to efferent fibers is 9:1 for the vagus and 3:1 for splanchnic nerves, while it decreases to 1:1 for pelvic nerves.[10]

Visceral reflex arcs are polysynaptic. Although knowledge about the central ending of visceral afferent nerves is insufficient, it is assumed that they synapse with cells in the dorsal horn of the spinal cord and join interneurons, some ascending

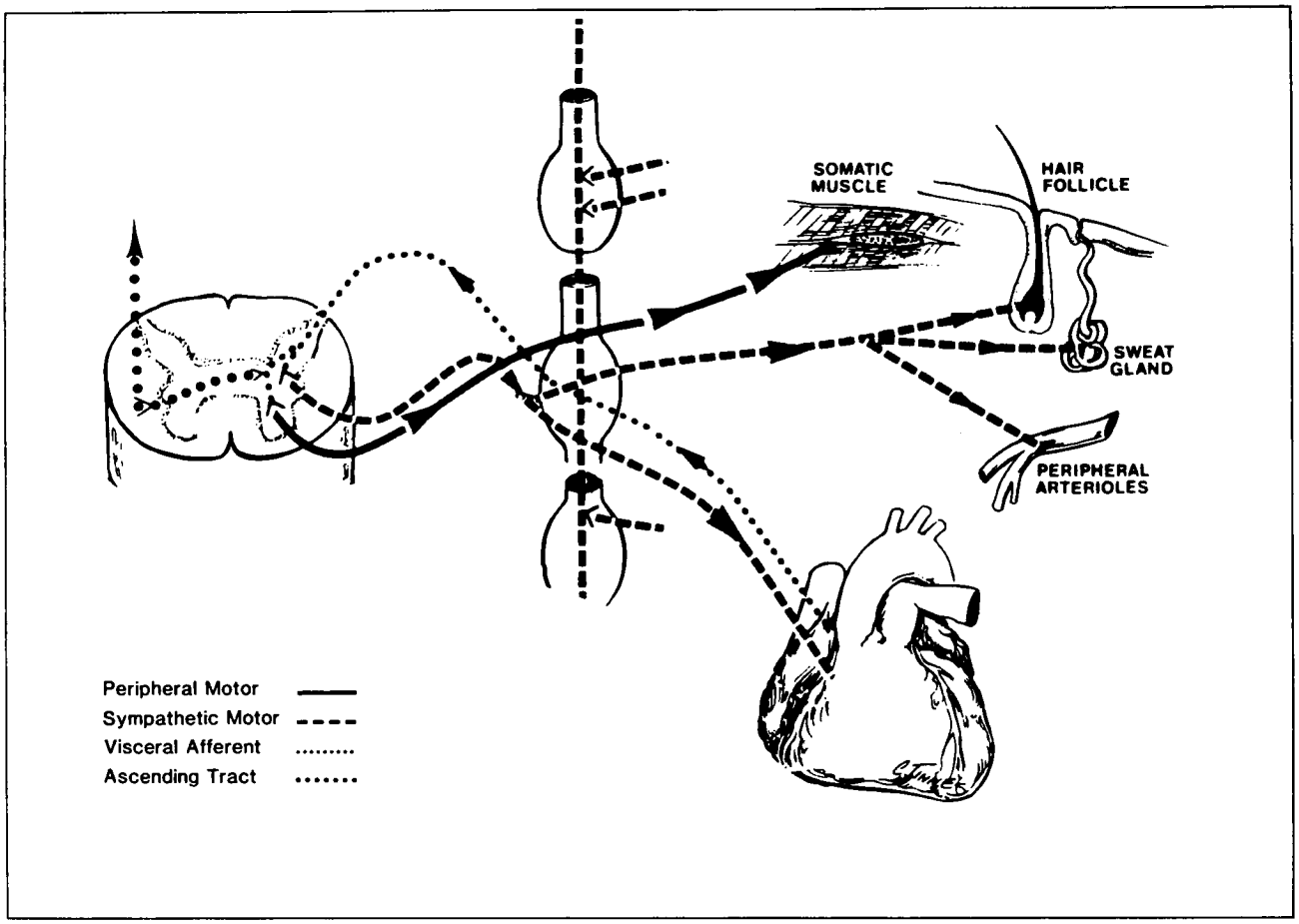

Fig. 1. *Schematic representation of the viscerosomatic reflex.*

in the anterolateral funiculus of the cord to higher centers and others connecting with autonomic and peripheral efferent nerve fibers.

Stimuli from viscera, somatic structures, and higher centers all converge at the T-cells of lamina 5 of the dorsal horn of the spinal cord.[11] The proximity of the sensory input provides a theoretical opportunity for interrelationship between the somatic and visceral systems and the higher centers. This may be expressed in terms of facilitation, suppression, or recruitment.

An abnormal stimulus of the visceral efferent neurons may result in hyperesthesia of the skin and associated vasomotor, pilomotor, and sudomotor changes. A similar stimulus of the ventral horn cells may result in reflex rigidity of the somatic musculature.[8] A direct motor connection between the visceral afferent system and the skeletal muscles has not been identified. Animal studies[12,13] have shown evidence of a viscerosomatic reflex that results in localized muscle contraction. Skeletal muscle spasm resulting from nociceptive visceral stimuli has been observed clinically in patients. These spasms may be manifest as generalized muscle contractions or as localized paravertebral muscle splinting.

Higher centers of the central nervous system acting through the extrapyramidal system on the muscle spindle through the gamma system could account for the muscle splinting reaction observed with visceral disease. Muscle spindles have a sympathetic fiber innervation.[7,14] Repetitive stimulation of these nerves increases the afferent discharge of receptors and could lead to an increase in gamma activity setting the spindle at a more active level, increasing the tone of the extrafusal fibers and resulting in an increased tonic muscle activity.

Reflex activities of the autonomic nervous system are characterized by spinal components of the reflex response originating from afferent stimuli of various viscera, which results in a confined or segmental reflex response. This is in contrast to a supraspinal response, which is mediated through higher centers and results in a more generalized body reaction. The spinal reflex response is elicited

by a small part of the spinal autonomic neuron pool, as compared to the larger number of neurons in the sympathetic pool that are activated by the supraspinal pathway. In certain situations all elements of the sympathetic outflow are involved, whereas in others there is a degree of specificity in the pattern of reflex response. Depending upon the afferent nerve stimulated, stimulation of visceral afferents results in different effector organ responses. The autonomic system plays a role in total body functions, and somatic and autonomic responses are component parts of all behavior reactions. They are best described as a dual motor outflow from a common central nervous system. The nature of the afferent signal, the integrative action of the spinal cord or higher center, and the past stimulus experience of the organism are all involved in the determination of the quality and components of the reaction.[7]

Experimental research

Experimental research[15-20] that was designed to elicit a somatic response to stimulation of viscera or visceral afferent nerves has demonstrated reflex responses in the lower extremities and abdominal musculature. Eble[12] reported that stimulation of the renal pelvis, ureter, fallopian tube, small intestine, or colon in rabbits resulted in reflex muscle contraction of the paravertebral muscles. The location of the muscular response varied with the organ stimulated.

Hix[21] provided further evidence of the localized effect of visceral stimulation on somatic structures by showing that a unilateral ureterorenal reflex can produce a significant enlargement of the unilateral cutaneous receptive field, while Schoen and Finn[13] demonstrated a localized muscle response in the upper thoracic spine of cats that was associated with acute periods of coronary ischemia.

The latter experiments show a localized somatic segmental effect—both cutaneous and muscular—resulting from visceral stimulation. These components of the somatic response to visceral stimulation have been of particular interest to members of the osteopathic profession.

Somatic manifestations of visceral disease

The existence of viscerosomatic reflexes and their detection by palpatory examination has been acknowledged. Grainger[22] states that the somatic manifestations of visceral disease are an integral part of the disease process, rather than just physical signs and symptoms. Although multiple factors have been suggested as causative agents for the development of viscerosomatic reflexes, the definitive etiologic factors and the characteristic response of the individual are still unknown. Pain is commonly associated with the development of a somatic manifestation of visceral dysfunction; it is a frequent presenting symptom in acute conditions that are related to the heart and gastrointestinal system.

The strength and duration of the visceral afferent stimulus necessary to effect a somatic response is not known. It is recognized that visceral afferents may be reinforced by somatic stimuli from skin and muscle, as well as by impulses from higher centers, which may lower the threshold for visceral afferents or facilitate their action at a specific spinal cord level. Prior facilitation of a cord segment or cord learning may enable a weaker visceral afferent stimulus to effect a somatic response. The answer to the question of what is an adequate stimulus is dependent upon the interactions of the strength of the afferent stimulus, the state of the spinal cord, the response of higher centers, and the prior experience of the subject.

It has been a tenet of the osteopathic profession that presymptomatic signs of visceral disease may be evident in the somatic system. Korr[6] reported a characteristic electrical skin resistance pattern in a subject 3 weeks prior to the development of coronary occlusion. The prognosis of somatic dysfunction observed in a cardiac reflex site in an asymptomatic patient raised critical questions for Wilson.[23] Did the somatic dysfunction indicate a potential for coronary occlusion, and would manipulative treatment of the somatic dysfunction reduce the likelihood of a coronary accident? Beal and Kleiber[24] noted viscerosomatic reflex changes in patients with subclinical coronary artery disease (as determined by cardiac catheterization).

Early signs of most disease states are manifested as symptoms and signs that are part of a common reaction pattern to injury or stress. Palpatory cues of transient muscle hypertonicity and irritability or subcutaneous edema may be accompaniments of ill-defined subclinical states. It is only with the continued activity of a particular stressor that the body response is characterized by specific changes that are associated with a particular disease state. Transient palpatory cues may be significant when they are observed to be part of a recurring disease pattern in a particular patient. In many functional disturbances of visceral disease (for example, gastritis), a somatic reflex pattern may be evident, but it disappears as the condition subsides, only to recur if the organ dysfunction returns. In some individuals, the somatic dysfunction may remain as a latent image manifested by subtle changes in tissue texture and joint mobility,

which are identified only by critical palpatory evaluation.

The early signs of acute reflex activity are similar to those observed by Larson[25] in cardiac patients in the intensive care unit. These reactions include: vasomotor reaction, with an increase in skin temperature; sudomotor effect as evidenced by an increase in moisture on the skin, which is reflected by an increase in skin drag; skin textural changes, such as thickening; increased subcutaneous fluid; and increased muscle contraction. These changes are localized to the autonomic spinal reference site for the particular viscus involved. They gradually decrease as the acute phase subsides; the subcutaneous edema lessens, and the patient enters the healing phase and the stage of chronicity.

In some patients, the reaction in the acute phase of an organic disease may be that of a typical somatic stress reaction pattern for that particular patient. As the condition progresses, the somatic stress pattern subsides, and the typical visceral reflex pattern is seen.[4,26]

The chronic phase of reflex activity is characterized by trophic changes in the skin, increased thickening of the skin and subcutaneous tissues, and localized muscle contraction. The muscles are hard and tense, and they may be hypersensitive to palpation.[27] The superficial muscles are usually less involved than the deep musculature, which is characterized by a deep confluent splinting contraction that involves two or more adjacent spinal segments and that is associated with a restriction in segmental spinal motion.[26] The deep tissue response may be more evident in the region of the costotransverse articulation.

Patterns of the somatic response to visceral disease are unique for each individual in terms of location, the number of spinal segments involved, and whether there is unilateral or bilateral involvement. The intensity of the tissue response differs among individuals and among disease states. In general, the reactivity of the tissue response is greater in patients with pain from serious organic disease. Preliminary observations[26,28] suggest that the intensity of the somatic dysfunction is greater in patients with cardiac and gastrointestinal problems who present with symptoms of severe pain than in patients with pulmonary disease, who are more apt to present with symptoms of dyspnea. A viscerosomatic reflex is seen in a high percentage of patients with coronary artery disease, whereas it may not be apparent in patients with certain cardiac arrhythmias, such as supraventricular tachycardia. Ischemia, pain, and life-threatening conditions may include a psychic rein-

TABLE 1. SEGMENTAL SYMPATHETIC NERVE SUPPLY.*

Author(s)	Heart	Lungs	Esophagus	Stomach	Small intestine	Large intestine (splenic flexure)	Large intestine (splenic flexure to rectum)	Appendix	Liver	Gallbladder
Gray[32]	T1-T5	T2-T4	T5-T6	T6-T10	T9-T10	T11-L1	L1-L2		T7-T9	T7-T9
House and Pansky[33]	T1-T5	T2-T5		T6-T10	T6-T10	T6-T10	T6-T10		T5-T6	
Crosby and associates[34]	T1-T5 (T6)	T3-T4 (T5)	T5-T6	T7-T9	T9-T12	T9-T12			T7-T8	T9-T10 (R)
Bhagat and associates[35]	T1-T5	T2-T7	T5-T6	T6-T9	T9-T10	T11-L1	L1-L2	T10-T12	T9-T10	T9-T10
Pottenger[36]	T2-T8 C3,C4	T4-T9 C3,C4		T7-T9	T9-T12				T7-T10	T8-T9
Brodal[8]	T1-T4 (T5)	T2-T7 (T2-T4)		T6-T10 (T5-T11) (T5-T9L)	T6-T10 (T5-T11)		L1-L2	T10-T12	T7-T9 (R)	T7-T9 (R)
White[37] (afferent)	T1-T3			(T6) T7,T8 (T9)	T9,T10 (T11)	(T11) T12-L1	S2-S4		(T6) T7,T8 (T9)	(T6) T7,T8 (T9)
Bonica[30] (afferent)	T1-T4 (T5)	T2-T7	Upper T2-T7 (T8)	T6-T9	T6-T8 (T10) duodenum T9-T11 jejunem ileum	T12-L1	L1-L2	T10-T12	T5-T9	T5-T9
Bonica[30] (efferent)	T1-T4 (T5)	T2-T7	Upper T2-T4 Lower T5-T7	T6-T9 (T10)	T6-T11	(T11) T12-L1	L1-L2	T10-T12	T6-T9 (T10)	T5-T9 (T10)

* The segments shown in parentheses indicate less frequent findings. L = left; R = right.

forcing component, which will produce a more intense reflex response.

The factors that initiate viscerosomatic reflexes and maintain them are not known. Subthreshold segmental facilitation can be observed in some patients for many years after an operation for gallbladder surgery.[29] It has been suggested that higher centers may play an important role in the production and maintenance of visceral reflexes. It is not known whether the continuation of the reflex somatic dysfunction is related to the initial impact of the visceral disease, or whether it is a result of long-term segmental facilitation.

Spinal segmental sites for somatic dysfunction associated with visceral disease are related to the autonomic nervous system supply for various organs. The site location has been plotted on the basis of animal experimentation and observations on humans from regional nerve blocks used to define pain pathways.[30] Somatic reference areas, which were first identified by Head,[31] have been modified by other observers[8,30,32-37] (Table 1). Bonica [30] has listed the autonomic afferent and efferent innervation for the various organs, while White[37] lists the afferent innervation; the specificity of nerve supply is lacking in the other sources. When the autonomic reference sites in Table I are plotted (Fig. 2), 3 distinct groups of viscera are seen, as follows: T1-

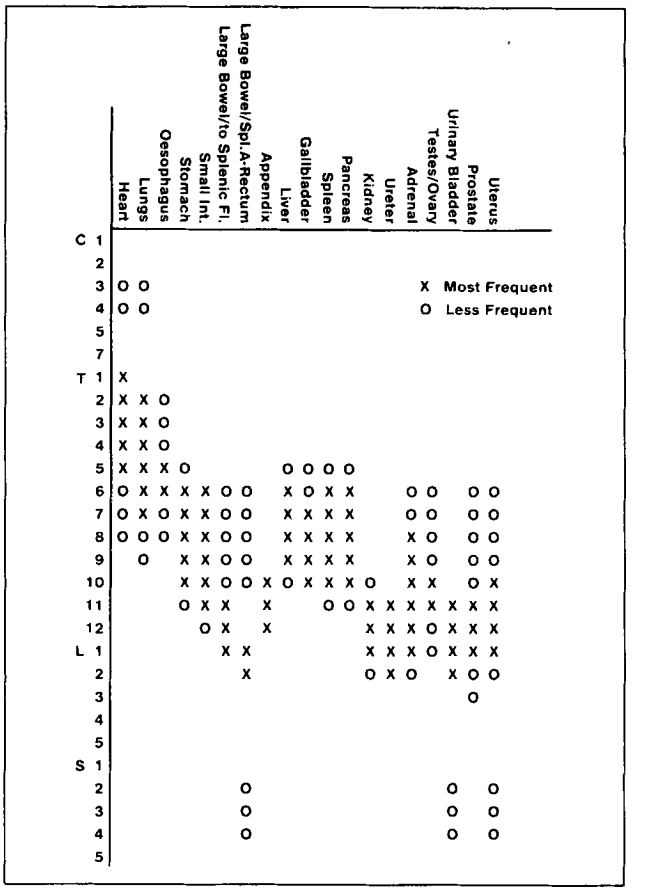

Fig. 2. *Site location of segmental sympathetic nerve supply.*

Spleen	Pancreas	Kidney	Ureter	Adrenal cortex	Adrenal medulla	Testes, Ovaries	Epididymis	Urinary bladder	Prostate gland	Uterus	Ureterine tube
T6-T10	T6-T10	T10-L1	T11-L2	T8-L1		T10-T11	T11-T12	T11-L2	T12-L1	T12-L1	T10-L1
	T5-T6 T7-T9	T10-T11 T11, T12-L1	T11, T12-L2			T9-T10		T11-L2 T11, T12-L1 (L2)	L1-L2 (L3)	T10-L2	
T6-T10	T6-T10	T11-L1 T11-L1	L1-L2			T10-T11 T10		T11-L2		T10-L1 T12-L1	
T6-T10 (T5-T11)	T6-T10 (T5-T11)	T12-L1 (T11-L2)	L1-L2 (T11-T12)		T11-L1 (T10-L2)			L1-L2 (T11-L2)			
		(T11) T12-L1	L1-L2					S2-S4		T11-L1 S2-S4	
	T6-T10	T11, T12-L1	T11-L2			T10-L1		T11-L1	T10-L1	T10-T12 (L1)	
	T6-T10	(T10) T11-L1 (L2)	T11-L2	T6-L2		T6-L1		T11-L2	T6-L1	T6-L1	

TABLE 2. VISCERAL SOMATIC REFERENCE SITES (ADAPTED FROM HANSEN AND SCHLIACK[38]).

Organ	Spinal reflex site	
	Cervical	Thoracic
Heart	C3,C4	C8,T1-T8
Lung	C3,C4	T3-T9
Pleura	C3,C4	T2-T12
Stomach	C3,C4	T5-T9
Duodenum	C3,C4	T6-T10
Jejunum	C3,C4	T8-T11
Large bowel	C3,C4	T9-L1
Appendix	C3,C4	T9-L1
Liver	C3,C4	T6-T11
Gallbladder	C3,C4	T6-T11
Spleen	C3,C4	T7-T10
Pancreas	C3,C4	T7-T9
Kidney	C3,C4	T9-L2
Ureter	C3,C4	T9-L2

T5—heart and lungs; T5-T10—esophagus, stomach, small intestine, liver, gallbladder, spleen, pancreas, and adrenal cortex; and T10-L2—large bowel, appendix, kidney, ureter, adrenal medulla, testes, ovaries, urinary bladder, prostate gland, and uterus.

Based upon clinical studies of patients with various types of visceral disease, tabulation of viscerosomatic reference sites has been presented by Hanson and Schliack[38] (Table 2). They identified reflex sites for different organs by palpatory examination of tissue texture change, vasomotor change, and hyperalgesia. Tables for each organ studied list a number of patient diagnoses and clinical findings. In addition, there are individual case studies to illustrate different organic conditions; each includes a diagnosis, examination findings, diagrams of pain reference zones, and laboratory test results.

Areas of somatic dysfunction associated with visceral disease have been identified by palpatory examination by a number of physicians. Members of the osteopathic profession have shown a particular interest in the identification of somatic dysfunction related to organic disease. Observations of various investigators[3,6,23-26,39-130] are presented in Table 3 and are charted in Figure 3. For the most part, these findings are similar to the charted autonomic nerve supply data in Table 1 and Figure 2.

Although there is considerable correspondence in the data presented, it is noteworthy that a designation of sidedness is made in certain unpaired organs. Findings of left sidedness are recorded in disease of the heart and small intestine, and right-sided findings are reported in gallbladder disease and appendicitis. Both right- and left-sided findings were observed in disorders of the stomach. Variability in observations of the reflex reference area for different viscera may be accounted for by the potential individuality of the autonomic nervous system innervation in different persons, as well as varying degrees of accuracy of the observers in recording spinal findings.

Referred pain

Pain of visceral disease that is referred to a somatic area that is supplied by the same or adjacent spinal nerve segments has been the object of considerable study.[31,131-134] The terms "referred pain" and "viscerosomatic reflex" have been used interchangeably for a phenomenon that includes cutaneous hyperesthesia, vasomotor changes, and contraction of skeletal muscle. Early investigators studied the cutaneous distribution of pain referred from various organs. Visceral pain perceived in a somatic area was called a viscerosensory reflex, and skeletal muscle contraction resulting from visceral afferent stimulus was called a visceromotor reflex.[133]

The concept of a central excitatory state of the spinal cord is basic to the hypothesis of referred pain. Visceral afferents initiate the central excitatory state, and their action may be facilitated by somatic afferents from skin and muscle or by supraspinal stimuli. Once the excitatory state has been created, its activity may be increased or maintained by further visceral stimuli, as well as by afferent stimuli from somatic structures and higher centers. A cyclical pattern of neuronal activity in the inner connector neurons of the spinal cord is postulated. This would maintain a lower threshold of sensitivity or facilitation to stimuli acting on the segment. The excitatory state may be maintained by stimuli unrelated to the initiating event, and it is thought that the excitation may be maintained for long periods of time after the initiating stimuli have ceased, thus resulting in continued cutaneous hyperesthesia and skeletal muscle contraction.

Clinical studies

Clinical research studies of visceral disease and its somatic components have been directed to the identification of somatic manifestations of visceral disease and the effectiveness of manipulative treatment of somatic dysfunction on the disease process. Early studies described the location and some characteristics of the identified somatic dysfunction, but authors failed to describe the tests used to determine the somatic components.

Wilson[117] presented data on an early study of palpatory examination of a group of patients whose diagnosis was not known to the examiner. Somatic dysfunction was localized in the region of

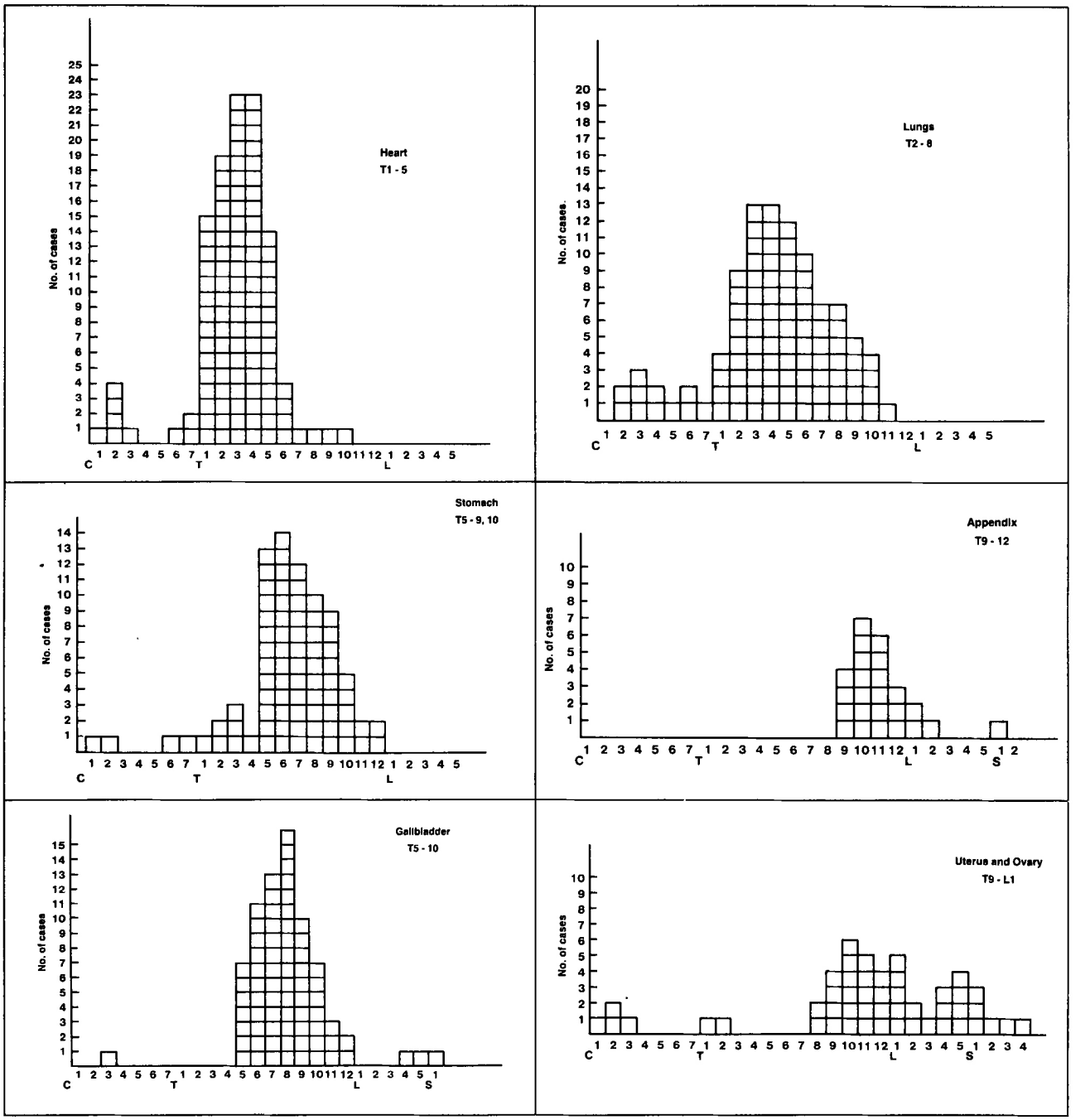

Fig. 3. *Graphic representation of viscerosomatic reference sites reported in the osteopathic literature.*

C3 and T8 in 19 cases of gallbladder disease in contrast to patients with other diagnoses. Long and Deming[1,2] and Deming and Kruener[3] reported the results of palpatory findings in patients with disorders of the gastrointestinal tract, heart, lungs, and female genital tract. Limited statistical verification was obtained for the characteristics of somatic dysfunction that were tested. Lindberg and associates[94] found that somatic dysfunction of T7, T8, T10, and L5 were significant in a study of patients with colitis. The criteria for the palpatory findings were listed, but the testing methods were not specified. Woods[96] reported that presurgical palpatory findings of a viscerosomatic reflex correlated with the diagnosis in 10 of 13 patients who had acute abdominal disorders.

A 5-year, double-blind study of 5,000 hospitalized patients who were examined for evidence of somatic dysfunction and its relationship to diagnosis was reported by Kelso.[4] Details of the examina-

TABLE 3. VISCEROSOMATIC REFERENCE SITES FROM THE OSTEOPATHIC LITERATURE.

Observer	Findings	Remarks
	HEART	
Barstow (in Patriquin[39])	T3-T5,upper ribs left	
Beal[24,26]	C2,T1-T5 left	
Beasley[40]	Ribs 1-2 left	
Becker[41]	T1-T6,ribs 3-5 left	
Burchett[42]	T1-T4	
Burns[43]	T3,T4	
Champlin and Champlin[44]	C2,C4,C5,T3,T4, ribs 3-6 left	A single case
Cox and associates[45]	C3,T4,T5	
Glascock (in Northup[46])	T3,T4	
Hart[47]	C7-T5, most prominent T1-T3	
Johnson[48]	Rib 2 left	
Kelso and associates[5]	T1-T4	
Koch[49]	T2-T6	
Korr[6]	T1-T4	Low skin resistance areas
Larson[25]	C2 left,T2-T5	Left side predominance
Long[50]	T1-T10	
MacBain[51]	C1-C2,T2-T5	
Patriquin[39]	T1-T4,ribs 1-4 left	
Robuck[52]	T3,T4	
Singleton[53]	T1-T3,ribs 1,2,5	
Snyder[54]	T1-T4,T5 occasionally, ribs also	
Steunenberg[55]	C6-T5,upper ribs left	Myocarditis
A.T. Still symposium[56]	T3,T4	
Waitley[57]	T1,T6	
Walton[58]	T1-T4 left	
Wilson[23]	T1-T5,ribs left	
	LUNG	
Bolton[59]	C3-C4,T4-T9	Chronic pulmonary disease
Burns[60,61]	T1-T3	Asthma
	T3-T5	27 cases asthma
	T2-T7	Nervous control of lungs
	T7-T10	Tuberculosis
	T8-T10	19 cases laryngeal tuberculosis
	T8-T11	15 cases upper lobe tuberculosis
	T6-T10	38 cases middle and lower lobe tuberculosis
Bush[62]	Ribs 5-8 right	Asthma
Crane[63]	T3-T4	Lobar pneumonia
Deming and Kruener[3]	C2-C4, T1-T6	183 cases disorder of the respiratory tract
Facto[64]	C2,C3,T3,T6	1 case bronchitis
Goode[65]	Rib 5	Asthma
Grainger[66]	T3-T4	Lobar pneumonia
Gravett[67]	C5,C6,rib 1, clavicle	Acute and chronic bronchitis
Hoag[68]	Upper thoracic area, especially T1-T6	Chronic lung disease
Howell and associates[69,70]	T3, right costotransverse articulation,T2 left	Chronic obstructive lung disease
	Thoracic spine—extreme restricted mobility, most pronounced at T4-T5	1 case pulmonary disease
Keene[71]	T2-T5, ribs 1,2 depressed	1 case tuberculosis
	T4-T5 right, ribs 4,5 depressed right	1 case tuberculosis
	T2 right, T6-T7 left, rib 2	1 case tuberculosis
Kline[72]	T2-T8	Respiratory infections
Koch[73]	Cervical and upper thoracic spine	Asthma
Magoun[74]	T2-T4	Bronchi and lungs
McWilliams[75]	C6,C7,T3,T4, sacrum	Asthma
Wilson[76-78]	T4,T5	20 cases asthma
	Occiput,T4,T5,ribs 4-5 bilaterally	Asthma
	Rib 5 left	1 case asthma
	STOMACH	
Northup[79]	T5	1 case chronic gastritis
A.T. Still symposium[56]	T5	
Burns[80]	T5-T10	Acute gastritis
	C6,C7,T2-T4	1 case chronic gastritis
	C1,C2,T2,T6,T12	1 case chronic gastritis
	T9,10,ribs involved	1 case
Brigham[81]	T5-T7 left	Ulcer, inflammation of stomach
	T5-T9, inflammation of T5-T7	
Conley[82-84]	T5-T9, particularly T5,T6	Peptic ulcer
	T9-T12	Peptic ulcer
Gibson[85]	T5-T9 left	
Glascock (in Northup[46])	T3 right	
	T1,T3 right T6-T8, ribs right	Acute indigestion
Halladay[86]	T8	Gastric ulcer
Kranz[87]	T5-T7	Gastritis
Mattern[88]	T6,T7,upper cervical area, and T5-T10	
Magoun[89]	T5,T6 right T6-T8 left T5-T7 left	
Meyers[90]	T5, spastic neck	1 case gastric ulcer
Muttart[91]	T6-T10	Gastric ulcer
Waitley[57]	T5-T9, most importantly T5-T7	
	SMALL INTESTINE	
Brigham[81]	T8,T9	
	T5-T7 left	Pyloric ulcer
Gibson[85]	T8-T10 left	Pylorus, inflammation of
	T6-T9 left	Duodenum, areas of referred pain
Kranz[87]	T5-T7	Duodenum, inflammation of
Magoun[89]	T5-T12, particularly T8,T9	
	T5-T7 right	Duodenum, functional conditions of
Martin[93]	T6,T7 left	Duodenal ulcer with cholecystitis

LARGE BOWEL

Lindberg[94]	T7,T8,T10,L5	Colitis
Northup[95]	Lower dorsal or lumbar area	Colitis
Waitley[57]	T5,L3	
Woods[96]	T12-L2	1 case strangulated inguinal hernia, left indirect

APPENDIX

Brigham[97]	T9,T10	
Gibson[85]	T9-T11 right	
Glascock (in Northup[46])	S1 right	
Kani[98]	T11	
Laughlin[99]	Rib 10 right	1 case appendicitis
Magoun[74,100]	T9-T11 right	
	T10-L2,tender spot T11 right	
Millard[101]	Lowest thoracic and lumbar areas	
Smith[102]	T9-T12	1 case appendicitis
Wilson[103]	Group curve right, apex at T10	
Woods[96]	T11-L1 bilaterally	

LIVER

Magoun[74,92]	T6-T8 right	
	T5-T7 right	
McWilliams[75]	T8, midthoracic region right	
Peckham[104]	T9±2 segments (T7-T11)	
Waitley[57]	T5-T9	
Wilson[105]	T10 right	1 case

GALLBLADDER

Becker[106]	Ribs,T5-T12	Vertebral lesion (flexion type)
Bell[107]	T6-T8	1 case gallstones
Brigham[81]	T5-T7 right	
Burns[108]	T9-T10, vertebral and costal lesions, frequently rib of T10	
Conley[84,109,110]	Rib 9, T12, T5-T9,T7 most frequent location	
	T7, pain to right of T8-T11 spinous process	
Denslow[111]	T8, L4-L5, left sacroiliac joint	1 case cholecystitis and colitis
Downing[112]	T8-T10, including ribs, especially costovertebral joint right	
Gibson[85]	T6-T8 right	
Magoun[74,89,92]	T7 right	
	T5-T7 right	
	T6-T8 right	
Malone[113]	T5-T8, ribs bilaterally	
McWilliams[75]	T7,T8 midthoracic region right	
Northup[79,114]	Rib 8 right	1 case cholecystitis
Starks[115]	T8-T10 rigidity and immobility, including ribs	
A.T., Still symposium[56]	T10	
Townsend[116]	T5-T10 and ribs	
Waitley[57]	T5-T9	
Wilson[117,118]	T6-T9, ribs right C3,T8	

SPLEEN

Gibson[85]	T8-T11 left	

PANCREAS

Gutensohn[119]	T6-T11	Paravertebral tenderness
Magoun[89]	T5-T10 left	
Wilson[120]	Occiput,T7,T10	Diabetes

KIDNEY

Burns[61]	T12-L1	Renal tuberculosis
Barstow (in Conn[121])	T11	Nephritis
Blackslee (in Conn[121])	T12	
Ellis[122]	Lower thoracic area, upper lumbar region, 3 lower ribs, frequently rib 12	11 cases
Gibson[85]	T9-T11	
Magoun[74,89,92]	T11-T12	
	T10-L1	
	T10-T12	
Nelson[123,124]	T5-L3, principal area	
	T9-T11, most specifically T10	
Smith[125]	T7-L3, flat, extreme rigidity	
Strachan[126]	T10-T12	

URINARY BLADDER AND URETER

Gibson[85]	Lumbar and sacral areas bilaterally	Bladder
	Lumbar and sacral areas	Ureter
Wilson[127]	L5	

PROSTATE GLAND

Gibson[85]	Sacrococcygeal area bilaterally	
Glascock (in Northup[46])	L3,L4	
Wilson[127]	L5	1 case prostate and bladder disease

UTERUS AND OVARIES

Burns[61]	T8-T10	Tuberculosis of the uterine tubes
Detwiler[128]	C2,C3,T9-T11	1 case of dysmenorrhea
	L5 left innominate	
Gibson[85]	L4-S2	Ovarian and tubal disease
	Sacrococcygeal junction	Uterus
Glascock (in Northup[46])	L1	Menstruation
Hitchcock[129]	T8-T12,L1-L2, S3,S4	Primary dysmenorrhea
Laughlin[99]	Sacroiliac	1 case fibroids
	C1,C2,ribs 1,2 right	1 case cystic right ovary
	L1 spastic muscles of lower thoracic and lumbar areas	Retroverted uterus
	12 rib right, L1	
Magoun[74]	Lumbar area	Pelvic organs
Northup[79]	T12,L1,L2	1 case dysmenorrhea
Simmons[130]	T9-T12,L1	Ovaries, dysfunction of
	L3-L5,sacroiliac	Uterus, dysfunction of
	T10,11 right	1 case left ovarian and tubal disease
Woods[96]	T10-L1,L4,L5	1 case ruptured left ectopic pregnancy, right ovarian cyst

tion method, the tests used, and the results were presented. He concluded that most visceral diseases appeared to have more than one region with an increased frequency of segmental findings, that unpaired viscera have an increased frequency of findings on one side, and that the number of spinal segments involved appears to be related to the duration of the disease. In a second report, Kelso and associates[5] observed an increased incidence of palpatory findings in the cervical spine in patients with sinusitis, tonsillitis, disease of the esophagus, or liver ailments. Upper thoracic involvement was seen in patients with bronchitis, coronary artery disease, or chronic heart disease. Somatic dysfunction was significant at T5-T12 in patients with gastritis, duodenal ulcer, pyelonephritis, chronic appendicitis, and cholecystitis.

Larson[25] examined patients in the intensive care unit who had proved or suspected acute myocardial disease. Details of the palpatory tests and a description of the findings are contained in his report. He found a moderate dominance of left-sided findings at C2, T3, T4, and T5.

A pilot study using students in a blind format to identify somatic dysfunction in patients with visceral disease was presented by Nicholas.[135] No details of the tests or criteria for somatic dysfunction were given.

Cox[136] reported the results of a double-blind study of the significance of palpatory findings in coronary artery disease. He found a high correlation between palpatory findings at T4 and the presence of coronary artery disease as determined by cardiac catheterization. Nicholas[137] reported significant palpatory findings in the upper thoracic spine in a blind study of patients who had a diagnosis of myocardial infarction.

Beal[26] used a compression test to examine soft tissue texture changes and resistance to segmental joint motion. Somatic dysfunction at T1-T5 associated with cardiac disease and somatic dysfunction at T5-T12 associated with gastrointestinal disease were observed. In a blind study of 25 patients, he was able to differentiate patients with cardiac or gastrointestinal disease with an accuracy rate of 76 percent.

In a study by Beal and Dvorak,[138] the same testing procedure was used to examine 50 patients in a physician-blind format who had diagnosis of cardiovascular disease, pulmonary disease, gastrointestinal disease, or disorders of the musculoskeletal system. Significant signs of somatic dysfunction were found in the appropriate reflex site for the patient's diagnosis. Beal and Morlock[28] reported that 40 patients who had a diagnosis of pulmonary disease and were examined for evidence of somatic dysfunction had a predominance of spinal findings in the area T2-T7.

A study in which 99 patients were examined prior to a scheduled cardiac catheterization test was conducted by Beal and Kleiber.[24] A palpatory examination that utilized a compression test to assess tissue texture and joint mobility was carried out without knowledge of the patient's history or health status. The presence or absence of somatic dysfunction correlated with the cardiologist's diagnosis in 79 percent of the cases.

Johnston and coauthors[139] reported a physician-blind study of palpatory findings of vertebral and costal motion dysfunction and tissue texture change. Results revealed a statistically significant increased incidence of palpatory findings at T7-T12 in patients with renal disease as compared with patients with hypertension or normal blood pressure. The palpatory findings were associated with independent observations of increased skin temperature measurement.

Clinical studies of the effectiveness of the use of osteopathic manipulative treatment in visceral disease are limited. Two early studies in which the patient was used as his/her own control were presented by Wilson. In the first,[76] he reported the results of manipulative treatment in a series of 20 patients with a diagnosis of asthmatic bronchitis who were treated at the clinic of Peter Bent Brigham Hospital. He identified somatic dysfunction at T4 on the right, to which he applied specific treatment. All 20 patients had had prior vaccine treatment before the use of manipulation. Treatment resulted in at least temporary relief for 15 patients (50 percent improvement in 10 patients, and 4 of whom the attacks had practically ceased) and no relief in 5 cases.

Wilson also reported on a series of 12 patients as part of a research study[23] on the diagnosis and treatment of cardiac disease. Patients were examined by 3 osteopathic physicians independently and without knowledge of the history or medical record. A diagnosis based upon the evidence of somatic dysfunction in the area T1-T5 was found to correlate with the diagnosis of the cardiologist in 10 of 12 cases. Patients were given specific manipulative treatment on a weekly basis in addition to their medical management. Although there were no objective tests of clinical improvement reported, the patients in the series were symptomatically better.

Based upon palpatory and x-ray examinations, Koch[49] found evidence of somatic dysfunction in 100 cases of functional heart disease and 50 cases of organic heart disease. Somatic dysfunction was observed at T2-T6. Each patient served as his/her

own control and showed symptomatic improvement with manipulative treatment.

Miller[140] reported a controlled study of chronic obstructive lung disease in which patients were randomly assigned either to a group receiving standard medical care (control group) or to a group receiving both medical care and osteopathic treatment. Palpatory examination for somatic dysfunction was carried out by 2 osteopathic physicians who were blinded as to whether a subject was in the treatment or control group. A significant increase in somatic dysfunction was noted in the thoracic spine of both groups. Objective measurements of changes in tests of lung capacity were performed, and significant changes were not observed in the treated group as compared with the control group. However, the treated patients exhibited a decrease in objective evidence of somatic dysfunction, and they subjectively reported improvement in the ability to do physical work.

Diagnosis

The diagnosis of viscerosomatic reflex is based upon a history of visceral disease and the objective findings of somatic dysfunction on palpatory examination. Objective palpatory findings of a viscerosomatic reflex without an associated disease should lead to a review of the patient's history to see whether symptoms of a visceral disorder can be elicited. A general structural examination of the patient should be carried out with the patient in the standing, seated, and supine positions. A palpatory examination of the paraspinal tissues to elicit areas of tissue texture changes that are potential reflex sites is conducted with the patient in the seated position. It is important to identify tissue texture changes in the various soft tissue layers, as follows: the skin for changes in texture, temperature, and moisture; the subcutaneous tissue for changes in consistency and fluid; the superficial and deep musculature for tone, irritability, consistency, viscoelastic properties, and fluid content; and the deep fascial layers for textural changes. Emphasis is placed upon the palpation of tissue texture, because it is significant for identifying visceral effects in the somatic tissues.[26] Special attention is given to the examination of tissue texture at the costotransverse area, where it is felt that autonomic nerve effects are predominant.

Bony landmarks and joint motion tests may confirm the existence of areas of somatic dysfunction. However, in my experience, tests of the quality and range of joint movement have not been found to differentiate between visceral reflexes and somatic changes.

Palpatory examination of the patient in the supine position has been found to be definitive in the examination of patients for cardiac reflexes.[26] The deep confluent muscle splinting reflex effect is more apparent with the relaxation of the superficial muscles. The examiner's fingers are placed on the skin surface, and after ascertaining its quality, a compressive force is applied by the fingers so that the examiner may project his/her sensory awareness in turn to the subcutaneous tissue, superficial muscle, deep muscle, fascia, and bone, evaluating the consistency and the viscoelastic properties of each. Lastly, a compression springing motion test is effected by contacting the transverse process and springing it to elicit its quality of motion. The compression test is used in comparing the right and left side of an individual vertebra, as well as the vertebra above and below. The supine compression test is recommended because the side of the dominant palpatory pattern observed in the seated position may change when the patient is supine. This finding was observed in 25 patients in an examination for cardiac reflexes.[24]

The findings of a supine compression test are more difficult to evaluate in the lower thoracic spine because of the patient's weight on the palpating hands. Whether the prone examination position can be equally discerning for evidence of reflex change has not been tested, and examination of acutely ill patients often precludes the use of the prone position. Additional tests may be utilized for added information or confirmation of findings. These tests may include evaluation of the cervical spine, ribs, lumbar spine, and pelvis for evidence of reflex involvement.

The diagnosis of a viscerosomatic reflex is based upon the following criteria: 2 or more adjacent spinal segments that show evidence of somatic dysfunction located within the specific autonomic reflex area; a deep confluent muscle splinting reaction; resistance to segmental joint motion; and skin and subcutaneous tissue changes that are consistent with the acuteness or chronicity of the reflex.

Palpatory differential diagnosis of the origin of somatic dysfunction is difficult. Viscerosomatic reflexes are characterized by paravertebral deep muscle contraction at spinal areas that are associated with the autonomic nervous system visceral reference sites. Somatic change may be unilateral with single-organ or bilateral with paired-organ disease. Somatic change that is resistant to manipulative treatment should raise the physician's suspicion of a potential viscerosomatic reflex.

Psychologic stress often is manifested as a bilateral contraction of the superficial paraspinal musculature in the cervical and upper thoracic

spine. In cases of trauma, somatic dysfunction is usually predominant on one side, and the findings are segmental in nature. Tissue hypertonicity varies from segment to segment. There may be a greater viscoelastic effect to palpatory compression; that is, the barrier sense or end point is not as resistant to compression as in the case of the visceral reflex. A transverse process may be prominent and tender on palpatory compression, but it is segmental in nature, in contrast to a visceral reflex that involves 2 or more vertebrae in a confluent pattern. Differentiating a somatic response from a strain or sprain from that of a viscerosomatic reflex when 2 or more spinal segments are involved is difficult. In general, the strain or sprain is characterized by an individuality of the segmental response or is part of an established spinal curve.

The predictive value of palpatory findings in the diagnosis of visceral disease has not been established. As calculated by Cox,[136] the efficiency of palpatory tests of range of motion and soft tissue texture at T4 for correctly identifying patients who had coronary artery disease and those who did not is 75 percent and 73 percent, respectively. Beal[24] found a 79 percent efficiency rate for a palpatory compression test that identified the presence/absence of somatic dysfunction on the left at T1-T5 as a predictor of the presence/absence of coronary artery disease.

The palpatory diagnosis of viscerosomatic reflexes assists the physician in the differential diagnosis of somatic pain. When combined with other historic or physical evidence, a positive viscerosomatic reflex may enhance the predictive value of the diagnosis of visceral disease.

Treatment

Osteopathic manipulative treatment of viscerosomatic reflexes has been advocated on the basis that it is designed to reduce somatic dysfunction, to interrupt the viscerosomatic reflex arcs, to influence the viscus through stimulation of somatovisceral effects, and to reduce the potential preconditioning effect of somatic dysfunction to body stressors.

It has been proposed that manipulative treatment administered to the somatic reference area may effect a change in the viscerosomatic reflex arc, resulting not only in a decrease in the reaction of the paraspinal tissues, but also in a change in the automaticity of the feedback mechanism to the spinal cord, a reduction in the cyclical internuncial cord behavior, and a reduction in the visceral efferent stimulus, thus leading to a decrease in the adverse effect that is associated with repetitive visceral stimulation. The mechanism may be that of a somatic inhibitory stimulus conveyed to lamina 5 cells that effects inhibition or blocking of visceral afferents.[141] Treatment is also designed to reduce the residual effects in the somatic structures following a visceral disorder. Pain or disability may be manifest in the somatic reference area of a viscus after an acute attack of visceral dysfunction has subsided. Residual somatic dysfunction may also result from the lowered threshold of sensitivity attributed to facilitation of the segmental innervation, and the lowered threshold may permit general stress effects acting on the facilitated segment to replicate the pattern of muscle contraction or referred pain.

Treatment of the acute stage of somatic dysfunction associated with visceral disease is designed primarily to break into the reflex arc. In cases of serious illness, the treatment may consist of gentle digital pressure of short duration to effect a local change in the superficial tissues.[142] When relaxation has been accomplished in the subcutaneous and superficial paraspinal musculature, the deep muscle contraction may be addressed. The duration of treatment is dependent upon the patient's condition and perceived energy level. It is better to carry out multiple periods of treatment at short intervals than a single treatment of longer duration. Acute conditions that are not life threatening, such as asthma, may be addressed in a more aggressive manner to effect superficial and deep muscle relaxation, as well as to attempt to restore segmental joint mobility. The response to treatment of an acute organic dysfunction may be limited, because of the continued afferent stimulation from the diseased viscus. A limited response to treatment may continue until there is reduction of visceral disease and lessening of the afferent stimulation to the somatic tissues.

Acute disease states of a limited or functional nature, such as gastritis, may require treatment of the localized area of viscerosomatic reference, as well as treatment of contiguous areas of muscle tension that are either related to the visceral disorder or to the general stress response by the patient. In these patients, treatment to effect general relaxation may be as important as treatment of the specific viscerosomatic reference area.

In cases of limited visceral dysfunction, manipulative treatment is designed to reduce somatic dysfunction to a minimum. Treatment of a functional disorder such as a gastritis may result in a complete resolution of the somatic dysfunction. Improvement in the tissue response may parallel or precede the improvement in the patient's symptom profile. However, recurring episodes will usually

elicit a similar pattern of somatic response. The intensity of the reaction will vary with the intensity of the organ dysfunction. In chronic organic disease, somatic dysfunction may be evident as chronic myofascial change or as a latent image of the acute reflex pattern.

The effectiveness of manipulative treatment for the somatic manifestations of chronic organic disease has not been established. It has been proposed that long-term management programs result in a decreased incidence of recurrence of acute manifestations of disease, less somatic pain, less disability, and a decrease in the potential stress effects mediated through segmental facilitation. However, comparative studies of the results of manipulative management have not been made.

Osteopathic physicians[110,142-145] have advocated manipulative treatment as a part of the treatment regime for organic problems of the heart, stomach, and gallbladder, as well as for preoperative and postoperative management of patients with organic disease. Postoperative manipulative treatment has been commended as promoting a shorter, smoother convalescence from the effects of visceral disease, and, in some instances, as essential for the ultimate recovery of the patient's well-being.[110,145]

There is little information about the effect of surgery on viscerosomatic reflexes. Martin[93] reported a spinal reflex at T6-T7 on the left in a case of duodenal ulcer complicated by cholecystitis; the reflex had disappeared by the time of examination 2 weeks after surgery. Drew[145] observed that spinal reflexes in cases of acute appendicitis usually return to normal a few days postoperatively, but they may remain for several weeks after surgery. Kelso[4] found that segmentally related findings did not change in serial examinations of hospital patients who had undergone cholecystectomy, appendectomy, or hysterectomy. Chronic somatic dysfunction was noted by Denslow[29] in patients following gallbladder surgery.

Manipulative treatment has been used to treat somatic dysfunction associated with a variety of organic diseases. Downing[112] discussed the nonsurgical treatment of gallbladder disease and Mattern[88] the treatment of gastroduodenal ulcer. Denslow[111] presented a case history of acute cholecystitis and colitis, Meyers[90] reported on gastric ulcer, and Wilson[105] discussed liver disease. The long-term management of specific visceral conditions has been discussed by Wilson[23,76] (heart disease and asthma), Koch[49] (heart disease), and Facto[64] (bronchitis).

There is a definite need for further data on the incidence of viscerosomatic reflexes and the results of both surgical and manipulative intervention.

Comment

The role of the musculoskeletal system in health and disease is still ill defined. Although we have basic science confirmation of the existence of somatovisceral and viscerosomatic effects, the interrelationships of the somatic and visceral systems and the determinants of their manifold interactions is not clear. Are viscerosomatic manifestations the early signs of visceral disease, or do somatic afferents sensitize certain spinal cord segments and the related viscera, creating a predisposition to functional or organic disease? It is highly probable that the initiation of organic disease is a complex process of interrelationships involving visceral and somatic afferents, as well as stimuli from higher centers that is manifested by a highly individualistic selectivity based on prior experience and learning. The effect of higher centers on local somatic dysfunction related to visceral disease is not known. It is of interest that organic disease may be manifest in both a massive body reaction and/or a selectivity to a local segmental area.

We lack knowledge of the excitation causes of visceral afferent stimuli, the degree and localization of somatic response, the maintenance of both visceral and somatic irritability, and the short- and long-term effects of somatic dysfunction on the spinal cord and viscera. Studies have alluded to the possibility that visceral disease may have more widespread manifestations than the local autonomic related segmental component. Parasympathetic manifestations of visceral disease have received minimal documentation.

There is a need for the development of specific palpatory tests that are easily applied and that are highly reliable to aid the differential diagnosis of visceral disease. Researchers also require specific palpatory tests to assess the visceral manifestations of somatic dysfunction and the effectiveness of the use of manipulative treatment. Valuable information could be obtained from observing the short- and long-term effects of surgery on viscerosomatic reflexes. For example, how soon does the somatic component resolve following surgery? The prognostic value of palpatory tests will be substantially improved by studies of the long-term management of patients undergoing surgery or medical treatment for visceral disease.

The concept of viscerosomatic reflexes reflects the strong interest of the osteopathic profession in the relationship of the musculoskeletal system in health and disease. It was apparent to early practitioners in the profession that somatic dysfunction

was the result of multiple factors—somatic, visceral, and psychologic. The identification of viscerosomatic reflexes characterizes the early interest in the differential diagnosis of somatic dysfunction. It is hoped that continued efforts to explore the etiologic mechanisms of somatic dysfunction and the interrelationships of the nervous system will lead to further refinements in palpatory diagnosis and manipulative treatment.

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