An Osteopathic Approach to Gastrointestinal Disease: Somatic Clues for Diagnosis and Clinical Challenges Associated With *Helicobacter pylori* Antibiotic Resistance

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The estimated prevalence of gastritis in the general US population is approximately 50%. Patients with gastrointestinal disease often present to the primary care practitioner with dyspepsia and abdominal pain. Osteopathic palpatory evaluation suggests that there is an association among gastrointestinal disease, the presence of posterior midthoracic pain, and chronic headache. On the basis of findings from a review of the literature, the author assesses the potential etiologic mechanisms of this clinical association. Possible mechanisms include the physiologic function of the vagus nerve, a neural convergence model, and the inherent properties of *Helicobacter pylori*. To demonstrate the clinical significance of these mechanisms, the author presents the case of a 30-year-old woman with headache, thoracic discomfort, and gastritis associated with *H pylori* infection. The author suggests that successful treatment of patients with gastrointestinal disease includes osteopathic manipulative treatment, behavioral modification, and pharmacotherapy, even when challenged by antibiotic resistance.

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In the practice of clinical medicine, we commonly associate dyspepsia, abdominal pain, nausea, and anorexia with the possible existence of pathologic mechanisms for gastrointestinal disease. For each patient, the specific diagnosis is validated through evaluation of the medical history, physical examination, and diagnostic studies. At presentation, the patient's symptoms may be vague or may fail to typify the symptoms associated with internal disease processes. Gastrointestinal disease can exemplify this diagnostic challenge. Osteopathic palpatory evaluation offers a diagnostic tool for patients with gastrointestinal disease. On the basis of palpatory assessments of viscerosomatic reflexes performed over the course of 30 years of clinical practice, Jerry L. Dickey, DO, reported that gastropathologic conditions may correlate with thoracic pain and headache (Jerry L. Dickey, DO, oral communication, November 2005).

In the present article, I review the basic symptomatologic features of gastritis and demonstrate the association between somatic diagnostic clues and gastrointestinal disease. This review establishes the rationale behind the correlation between gastrointestinal conditions and headache. In addition, I report the case of a 30-year-old woman who presented with headache accompanied by intermittent nausea and bloating. This case demonstrates the current clinical challenges faced in the management of gastrointestinal diseases, including osteopathic manipulative treatment (OMT) and management of *Helicobacter pylori* infection.

Methods

To find relevant English-language literature published from January 1996 through February 2011, I performed a search of the National Library of Medicine's PubMed and MEDLINE databases, as well as Wolters Kluwer Health's UpToDate website, Epocrates Online, and the online archives of *The Journal of the American Osteopathic Association*. The key words used in the search were "antibiotic resistance," "cervicalgia," "drug resistance," "eradication effects," "headaches," "Helicobacter infections," "H. pylori," "IgA deficiency," "somatic dysfunction," and "thoracic pain."

Corporal Representation of the Disease State

The concept of correlating headache with gastrointestinal disease is not new to the literature. In 1906, G. D. Hulett, DO, wrote that "bilious" headache was the potential reflex resulting from a gastrointestinal disorder occurring in association with cervical lesions.[1] In 2003, Kappler and Ramey[2] documented that the vagus nerve had extensive interconnections to cranial nerves and the C2 vertebral segment. They further indicated that the vagus nerve was responsible for referred pain and parasympathetic reflexes, including posterior headaches referred from the throat, lung, heart, or bowel.[2]

Other studies have explored the effects of vagal nerve stimulation on migraine headaches[3] and the effects of pharmacologic eradication of *H pylori* on symptoms, including headache.[4] In 1995, Mavromichalis et al[5] reported that 29 of 31 children with migraine headache had an underlying associated gastrointestinal disorder, suggesting a gastrointestinal origin for the complaint.

The ability of the somatic system to reflect internal processes is a long-standing tenet of osteopathic medicine, as highlighted in the physiologic model of viscerosomatic and somatovisceral reflexes, including Chapman reflex points. In 1985, a review of the literature by Beal[6] provided clinical evidence from double-blind studies documenting the existence of viscerosomatic reflexes to internal physiologic processes. A study by Gwirtz et al[7] in 2007 demonstrated that manual palpatory assessment could be used to accurately predict the induction of cardiac ischemia in dogs. Despite these findings, it seems that the viscerosomatic reflex may be clinically underused to associate gastrointestinal disease–related pain with the paraspinal area of the posterior thorax.

Pathologic processes in the viscera are relayed to the spinal cord through afferent activity. This neural stimulus converges on the dorsal horn, where internuncial connections excite efferent stimulation through the ventral horn. The excitatory stimulus, transmitted through the ventral horn, results in spinal nerve activation, which is evident through textural changes in the associated muscle and skin and in articular findings. This "neurologic lens," which acts as an organizer and relay station, has been shown to have the ability to cross segmental boundaries (*Figure*).[8]

The end effects rendered through the somatic nervous system are commonly recognized as tissue texture abnormality, asymmetry, restriction of motion, or tenderness (ie, TART) criteria, which provide diagnostic clues regarding somatic dysfunction. Segmental dysfunction can be associated with vasoconstriction in the end organ, with impediments to both oxygenation and delivery of cellular nutrition creating a profound disadvantage in combating pathology.[9] As appropriately stated by Dr Korr,[9] "Everytime you correct somatic dysfunction you are returning to the autonomic nervous system the ability to make appropriate moment to moment decisions."

Clinical Presentation and Somatic Manifestations

Peptic ulcer disease (PUD) and symptomatic gastritis share similar symptoms, including anorexia and dyspepsia, as well as nausea and vomiting in more complicated cases. In the Rome II consensus report, dyspepsia was described as including pain or discomfort centered in

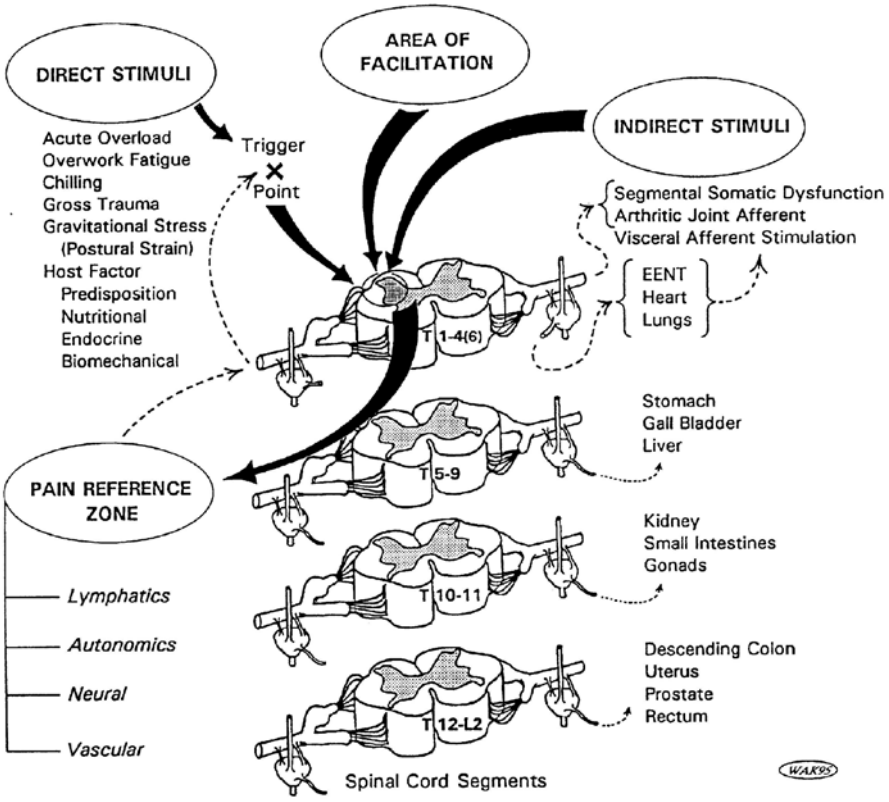

Figure.
Illustration of the spinal cord in its role as a "neurologic lens" for a variety of stressors that can initiate somatic or visceral symptoms. *Abbreviation*: EENT, eye, ear, nose, and throat. Reprinted with permission from Kuchera ML, McPartland JM. Myofascial trigger points. In: Ward RC, executive ed. *Foundations for Osteopathic Medicine*. Baltimore, MD: Lippincott Williams & Wilkins; 1997:916.

the upper abdomen, predominantly without heartburn or acid regurgitation.[10] Patients with dyspepsia may also present with complaints of early satiety, upper abdominal bloating, and epigastric burning. Classic symptoms of duodenal ulcers occur in the absence of a food buffer and have been associated with circadian stimulation, typically leading to awareness of dyspepsia and night awakenings between 11 PM and 3 AM.[11] Another component of the medical history of patients with gastrointestinal disease is that such patients typically report having a parent who has hyperacidity resulting in an increased consumption of antacids. Further findings noted by Dr Dickey included a history of night awakenings, occipital headache radiating to a retro-orbital location, and not eating breakfast (Jerry L. Dickey, DO, oral communication, November 2005).

On the basis of osteopathic palpatory evaluations conducted in his clinical practice, Dr Dickey revealed that, for patients with gastrointestinal disease, palpatory-based diagnosis includes an occipitoatlantal joint side-slipped to the left, an occipitomastoid suture restriction on the right side, and the C2 vertebra extended in a side-bent orientation and rotated to the right (Jerry L. Dickey, DO, oral communication, November 2005). Dorsal spi-

nal findings include a right-sided gastrointestinal reflex that is usually manifested with nonneutral mechanics at the T5 or T6 vertebra. Ventral palpation reveals an area of resistance to deep palpation subcostally and to the right of the xiphoid process. Dr Dickey described this area as corresponding with the duodenal cap (Jerry L. Dickey, DO, oral communication, November 2005). Palpation of the cranium often reveals decreased amplitude of the cranial rhythmic impulse in conjunction with the presence of inflammatory and infectious conditions.[12]

Patients may repeatedly present with complaints of thoracic pain and chronic headache only. They may have no awareness of dyspeptic symptoms, repeated episodes of heartburn, or night awakenings until questioned during a diligent review of systems. The presence of 1 or more of these symptoms or findings should encourage the clinician to prioritize a gastrointestinal condition in the differential diagnosis.

Proposed Physiologic Mechanisms of Headache

To discuss the mechanisms of headache of gastrointestinal origin, it is important to first recount the currently understood physiologic mechanisms of headache. The pain-sensitive structures of the head include the skin, muscles, periosteum, eyes, ears, nasal cavities, and sinuses. Intracranial sources of pain include the venous sinuses, arteries, and dura mater, particularly at the base of the brain. Nerve-related sources of pain include the optic, oculomotor, trigeminal, glossopharyngeal, vagus, and the first 3 cervical nerves.[13]

The trigeminal nerve relays nociceptive stimuli from the pain-sensitive structures above the tentorium cerebelli, leading to the perception of pain in the frontal, temporal, and parietal regions. The central connections of the trigeminal nerve include the spinal trigeminal nucleus, a sensory nucleus that spans from the mid-pons to the upper cervical region of the spinal cord. The somatotopic and functional organization of the spinal trigeminal nucleus permits the mapping of clinical symptoms in a specific region of the brain stem.[14]

The infratentorial structures of the head refer pain to the vertex and back of the head and into the upper neck by way of the first 3 cervical nerves. The cervical roots of these nerves have their central origin in the spinothalamic tract that terminates in the neurons of the spinal trigeminal nucleus. The facial, glossopharyngeal, and vagus nerves have been implicated in pain referral associated with the naso-orbital region, ear, and throat.[13]

Proposed Mechanisms of Headache in Patients with Gastrointestinal Disease

The exact mechanisms of headache associated with gastrointestinal disease have not been clearly defined. Proposed mechanisms include a vagus nerve model, a convergence-projection model, and an *H pylori* biochemical model.[15,16]

Vagus Nerve Model

A nociceptive role for the vagus nerve has not, to my knowledge, been proven. In 1992, Randich and Gebhart[17] reviewed vagal afferent modulation related to nociception. Chemical, electrical, and physiologic activation were included in their review, as were the nerve pathways of the cardiopulmonary, diaphragmatic, and subdiaphragmatic afferent nerves. Randich and Gebhart noted that the vagus nerve has facilitating, as well as inhibiting, features related to nociception in laboratory rats. They postulated that vagal afferent activation may have an aversive component, although they could not definitively associate the vagus nerve with changes in nociception.[17]

As reported in 2000, Berthoud and Neuhuber[18] used neural tracing to confirm the extensive branches of innervation provided by the vagus nerve. They concluded that the vagus nerve may be involved in nociception on the basis of an affective-emotional response, such as the

increase in blood pressure and tachycardia associated with the perception of pain.[18] Mönnikes et al[19] investigated a mechanism of hyperalgesia associated with irritable bowel syndrome, focusing on the role of vagal and nonvagal afferent sensory C-fibers and serotonin receptors in the mediation of visceral nociception. The neuronal activity associated with colonic distention was measured through the expression of c-Fos, an intercellular transcription factor, in the brain nuclei. The findings of their research led Mönnikes et al to conclude that the transmission of nociception involves distinct pathways and neurotransmitters, and that the activity of the tractus solitarius (1 of 4 contributing nuclei of the vagus nerve), in association with serotonin, was more involved in modulation of sensorimotor reflexes than in nociception.[19] Such studies bear witness to the uncertainty regarding the involvement of the vagus nerve in pain modulation.

Larrier and Lee[14] described the vagus nerve as containing somatosensory fibers (predominantly representing pain) that enter along the descending trigeminal tract and synapse along with axons in the trigeminal nerve that produce pain. Specifically, the cell bodies of the recurrent meningeal nerve are located in the superior vagal ganglion, passing through the jugular foramen. Larrier and Lee[14] believed that, at the level of the superior vagal ganglion, the 2 or 3 upper cervical spinal ganglia contribute cells to the recurrent meningeal branch of the vagus nerve. They hypothesized that this nerve complex innervated the dura mater over the petrous surface of the temporal bone, with other branches reaching the falx cerebelli, the occipital sinus, and the dura covering the suboccipital cerebellar surface.[14]

The aforementioned anatomic relationship provides the potential correlation needed to consider a gastrointestinal origin for headaches. Headaches may be initiated through gastric irritation via afferent signals through the vagus nerve. Ascension of this stimulus converges in the C2 vertebra, where a shared complex of nerve fibers is located. The convergence of neural information may include fibers of the greater occipital nerve, which clinically associate with an external distribution of head pain. The shared fibers of the recurrent meningeal nerve, also known as the sinuvertebral nerve, provide an additional pathway that may account for pain related to the posterior fossa.[20] The end result is the perception of pain in the posterior region of the head—in part through activation of the sensory nerve roots of the upper cervical region.

Another proposed mechanism of an association between the vagus nerve and headaches related to gastrointestinal disease involves the inherent properties of the vagus nerve.[20] According to this hypothesis, pain begins when gastric irritation is relayed through vagal afferent activation.[20] This activation leads to continued stimulation of the vagus nerve as it courses through the jugular foramen. The vagus nerve contains somatic afferent nerve fibers that originate in the meninges of the posterior fossa and foramen magnum and terminate on the spinal trigeminal nucleus.[20] Irritation of the afferent fibers of the posterior fossa may present as an occipital headache, and the association of the posterior fossa with the spinal trigeminal nucleus offers the pathway for a headache inclusive of frontal distribution.

Although the vagus nerve has been found to have 10 afferent fibers for every efferent fiber, the nature of these fibers lends discord to the aforementioned proposal of a vagus nerve model of headache associated with gastrointestinal disease. The visceral afferent information carried by the vagus nerve is of the β-afferent, or small-caliber, fiber system. Although the β-afferent fiber system is responsible for the perception of pain, the vagus nerve contains only a limited amount of β-afferent fibers. The majority of its fibers are large myelinated fibers responsible for reflexogenic control of the viscera.[18] In light of this characteristic, the role of the vagus nerve in nociception remains uncertain.

Convergence-Projection Model

The foundations of the convergence-projection model of referred pain, including spinal cord facilitation, offer a second model that may explain the phenomenon of

headache related to gastrointestinal disease. Part of the convergence-projection model of visceral pain holds that visceral afferent and somatic afferent fibers converge at the same level of the spinal cord, synapsing with interneurons and second-order neurons alike.[21] This convergence facilitates the transmission of painful stimuli to the thalamic system, where the signal transmission is generally perceived as being related to somatic structures.

In individuals with gastrointestinal disease, the gastric malady would provide the initial stimulus for nociceptive information. This information is transmitted via visceral afferent neurons that accompany the sympathetic nerve trunks.[20] The nociceptive signal is first conveyed to the dorsal horn and then to the lateral horn of the spinal cord. Visceral sensory information from the stomach generally corresponds to somatic segments approximating the T5-T9 area. Cervero[22] described second-order neurons that can be engaged through neural stimulation and functional divergence of the visceral afferent pathways through the central nervous system. The afferent stimulus originating from the viscera is splayed throughout the spinal cord through polysynaptic pathways.

Headaches may become associated with this neuronal process primarily in patients with a medical history that includes trauma to the upper cervical spine. The afferent stimulus travels up the spinal cord and synapses at the cervicomedullary junction, which corresponds to the dorsal horn of the spinal cord. This stimulus activates segments of the upper cervical complex.

Mechanical injury to the neck (caused by motor vehicle accidents, falls, etc) may result in a self-sustained circuit of primary afferent fibers that alter the activity of the interneuron pool (Jane E. Carreiro, DO, and Frank H. Willard, PhD; personal communication [class handout]; fall 2007). The "neuronal static" of facilitation decreases the amount of stimulation needed to reach the threshold of activation and register a nociceptive stimulus in the involved cervical segment. The neuronal information is processed in the same manner as if it came from a cervical nerve root.

The afferent stimulus terminates in the neurons of the spinal trigeminal nucleus. According to a proposal by the anatomist and neurobiologist Frank H. Willard, PhD, when this nucleus is stimulated, the thalamus perceives that the nociceptive information is being sent from cranial structures through the trigeminal thalamic and spinothalamic tracts (Frank H. Willard, PhD, oral communication, October 2005). Although the original insult lies within the afferent stimulus from the stomach, this information is processed by the spinal trigeminal nucleus through polysynaptic pathways. The information processed by this nucleus and its associated tracts causes the brain to respond in a manner that is consistent with its original programming for noxious cranial stimuli. The end result is gastrointestinal disease associated with the perception of headache.

Helicobacter pylori Biochemical Model

In a third model, the presence of *H pylori* is the cause of headaches. Studies have investigated the effects of pharmacologic eradication of *H pylori* on patients with migraine headaches, both with and without aura.[4,23,24] At present, conflicting evidence exists regarding these effects. However, credence for an association between *H pylori* and headache is based on the potential vasogenic effects that *H pylori* may have on migraines—effects that support a vasomotor process.

It is believed that a persistent inflammatory response may be associated with *H pylori*. Colonization of the bacteria within the gastric mucosa leads to local tissue damage and an immune response, which includes the release of cytokines and bioactive lipids. Some studies have shown an alteration in the production of interleukin-8, a cytokine that expresses chemotactic activity for neutrophils and T lymphocytes.[25] *Helicobacter pylori* has also been associated with the immunomodulating substances responsible for vasospasm and platelet aggregation. Researchers have proposed that this inflammatory response may be responsible for changes in vascular tone leading to migraine headaches.[4]

Tunca et al[23] demonstrated a positive correlation between the presence of *H pylori* and migraine headaches. In their study, approximately 85% of 70 consecutive patients with migraine benefited from eradication of *H pylori*.[23] Gasbarrini et al[4] found that the incidence of *H pylori* in 225 patients with migraines was approximately 40%. Eradication of *H pylori* was achieved in 83% of the study population, 77% of whom reported a decrease in migraine symptoms and 23% of whom reported that their migraines completely disappeared.[4]

Ciancarelli et al[24] investigated possible associations between headache and an increased vulnerability to oxidative stress under the influence of *H pylori*. They reported that patients' plasma oxidative status and systemic nitric oxide bioavailability were not modified by the presence of the bacteria. Thus, a correlation between *H pylori* and headaches was not substantiated by Ciancarelli et al.[24]

Overall, further evaluation of the possible pathogenic relationship between *H pylori* and migraine headache needs to be conducted before a firm correlation can be established.

Why Awareness Is Important

Gastropathies, including gastroesophageal reflux disease, nonulcer dyspepsia, gastritis, and PUD, each have their own degree of severity and their own associated comorbidities. Borch et al[26] found the prevalence of gastritis and duodenitis to be 50% and 32%, respectively, in a study of 501 volunteers from Sweden. The lifetime incidence of PUD is approximately 12% in men and 10% in women, and the financial impact of the disease in the United States is approximately $10 billion per year.[26] Both PUD and gastritis are often associated with *H pylori* infection, although they are also linked with the routine use of nonsteroidal anti-inflammatory drugs. Other causes of gastritis include alcohol use, a history of irradiation, autoimmune reactions, Crohn disease, gastric mucosal atrophy, multiorgan failure, portal hypertension gastropathy, and sarcoidosis.[27]

Definitive routes of *H pylori* transmission remain unclear, with the literature suggesting the existence of oral-oral, gastric-oral, and fecal-oral routes.[28] Approximately 50% of the world's population is infected with *H pylori*, with a prevalence ranging from 20% to 80%, depending on the country.[28] Chronic *H pylori* infection that presents as gastritis occurs in 30% to 50% of the world's population, and the majority of individuals with this type of infection are asymptomatic. Controversy exists regarding the association between dyspepsia and gastritis caused by *H pylori* infection. When dyspepsia accompanies chronic gastritis, *H pylori* infection has been reported in 20% to 50% of cases.[29] A greater correlation exists between PUD and *H pylori* infection, with 70% of duodenal ulcers related to H pylori infection.[29] Frank peptic ulceration has been reported to occur in 10% to 15% of individuals who have both *H pylori* infection and chronic active gastritis.[29]

The prevalence of chronic daily headache, as well as its association with gastritis due to *H pylori* infection, demands clinical awareness. Headache leads to more than 10 million physician's office visits each year in the United States, and it results in annual productivity losses of approximately $13 billion for US employers.[30] This condition is also associated with approximately $3.2 billion in annual expenditures for over-the-counter medications.[30]

In the following case report, I describe a woman in my clinical practice who had headache, thoracic discomfort, and gastritis associated with *H pylori* infection.

Report of Case

A 30-year-old woman presented to the office with complaints of headache, which she reported as occurring almost daily during the previous several months. She denied having symptoms such as vomiting, fever, chills, visual changes, and photophobia. The patient reported that her headaches sometimes occurred during the morn-

ing, but they typically occurred and were worse in the afternoon and evening. She also reported having intermittent nausea and bloating that, at times, became worse with eating. Although her symptoms often improved after taking 600 mg of ibuprofen, the patient was hopeful that OMT could also help alleviate her symptoms. She claimed that her headache symptoms were associated with cervicothoracic muscle tension and midthoracic pain. Headache predominantly occurred in the right occipital base region and occasionally extended in a retroorbital manner.

The patient reported having intense episodic intestinal "spasms" that seemed to correlate with her stress level and that could be relieved by taking 10 mg of dicyclomine hydrochloride when necessary. She frequently had heartburn, for which she took 2 tablets of bismuth subsalicylate as needed, and general fatigue, which she attributed to reduced sleep hygiene and numerous nighttime awakenings.

The patient's history was reviewed. She reported that she had hypersensitivities to penicillin, doxycycline, tetracycline, and sulfa-based medications, and that she had developed such adverse reactions as hives, diffuse erythema, and swelling of the extremities after taking such medications. Her medical history included hypothyroidism, which was appropriately managed with 100 µg of levothyroxine daily. Her family history was clinically significant for a father who had glaucoma and regularly used calcium carbonate (Tums; GlaxoSmithKline) and for a mother who had hypertension. She denied having any surgical history. Her trauma history was clinically significant for a 6-foot fall that occurred in early childhood and resulted in a fractured right clavicle and for a rear-impact motor vehicle accident that did not require medical intervention.

The patient was employed as a nurse in a hospital. She did not smoke, but she reported moderate consumption of alcohol in social settings.

Physical examination revealed that the patient had stable vital signs and cardiovascular findings that were within the range considered to be normal. Epigastric tenderness was noted on palpation, with resistance to palpation evident over the duodenal cap beneath the xiphoid process. The patient's abdomen was otherwise nondistended and soft. Findings from a neurologic examination were unremarkable.

Musculoskeletal evaluation revealed appropriate muscle strength in all extremities, although hypertonicity was noted within the occipitalis muscle bilaterally. Also noted were restriction of the right occipitomastoid suture; the C2 vertebra extended, sidebent, and rotated to right; the occipitoatlantal joint sideslipped left; the T6 vertebra extended, rotated, and sidebent right within a group curve; and the T5-T8 vertebrae rotated left and sidebent right. Sphenobasilar synchondrosis was detected without a primary strain pattern and with decreased amplitude of the cranial rhythmic impulse.

The patient's clinical presentation, in concert with the findings from an osteopathic palpatory assessment, suggested the presence of gastrointestinal disease. Classic symptoms of gastritis may include nausea and bloating (which the patient reported), in addition to vomiting, foul-smelling breath, and anorexia, which may be aggravated by eating. Decreased mucosal blood flow, in association with gastritis and the presence of a viscerosomatic reflex, are often associated with such somatic complaints as thoracic and abdominal pain.

Diagnosis

An empiric diagnosis of gastritis provides the basis for treatment initiation. Before testing was performed for the detection of *H pylori* infection, OMT was applied to ease the patient's somatic discomfort and to release the mechanical restrictions impeding vascular and lymphatic delivery of oxygen and cellular nutrition. In addition, a proton pump inhibitor (PPI) was initiated. Serologic testing, including testing for *H pylori* antibodies, was ordered.

Results of serologic tests were positive for the presence of *H pylori* antibodies. The patient's *H pylori* an-

tibody titer was 8.16 U/mL, with less than 1.0 U/mL considered the negative comparison.

Initial Treatment

Treatment initiation was complicated by the patient's hypersensitivity reactions, which included diffuse erythema, swelling, and pruritus. Because these reactions were present, it was imperative to adjust the first-line regimen for addressing the *H pylori* infection.

The patient began receiving a 14-day course of the antibiotics metronidazole (500 mg twice daily) and clarithromycin (500 mg twice daily) in combination with continued use of a PPI and bismuth subsalicylate. She was encouraged to eat breakfast every day, consume a protein-rich snack every 2 to 4 hours, and avoid ingestion of acidic foods. She was also instructed to consume yogurt daily and to take probiotic supplements.

Approximately 10 days after initiating pharmacologic treatment, the patient was treated with the following OMT techniques: high-velocity, low-amplitude; balanced membranous tension; muscle energy; and myofascial release. The most pronounced findings of OMT were the return of nonneutral thoracic mechanics; atlanto-occipital sideslipping to the left; occipitomastoid suture restriction; and the C2 vertebra extended, sidebent, and rotated to the right. These findings included a hard end-feel regarding range of motion, in addition to considerable bogginess in tissues related to the viscerosomatic reflex. Of note, during treatment the patient had nausea, loose stools, and headache, all of which apparently were adverse effects of the antibiotics.

Follow-up Treatment

The patient completed the 14-day antibiotic regimen and was seen for follow-up assessment approximately 2 weeks later. She appeared to have difficulty determining whether she believed her condition had improved, because she still perceived adverse effects from the antibiotic regimen.

Osteopathic structural examination indicated that the patient remained clinically stable. The examination did not demonstrate nonneutral mechanics of the thorax, but a group curve from vertebrae T5 to T8 was present. The C2 vertebra remained extended, sidebent, and rotated to the right, with moderate severity. The cranial rhythmic impulse was sluggish without a definitive strain pattern, and the occipitoatlantal joint favored left sideslipping. The occipitomastoid restriction was not palpated. The posterior occipital muscular triangle was noted to have hypertonic bands.

The patient was treated with OMT, and a 4-week follow-up appointment was recommended. Eight weeks after treatment initiation, she returned with persistent complaints of headache, thoracic pain, and dyspepsia. A gastroenterologist was consulted, and the case was reviewed at length. On the basis of the patient's unresolved symptoms, coupled with her exceedingly high *H pylori* titer, it was recommended that the pharmacologic regimen be reinstituted at a longer interval and that a third antibiotic be added to the regimen. The patient started a 21-day course of triple-antibiotic combination therapy (consisting of clarithromycin, metronidazole, and levofloxacin) with a PPI and bismuth subsalicylate. Her regimen also included a protein-rich diet and use of probiotics.

Several weeks after completing the triple-antibiotic combination therapy regimen, the patient continued to describe having headache and thoracic pain, but she appeared to accept heartburn and abdominal discomfort as an unavoidable aspect of life. During her follow-up visits, the patient expressed hope regarding potential clinical improvement, especially during posttreatment days 2 to 10. As her symptoms persisted over the subsequent weeks, however, she reported that she did not believe that her health was improving. Her clinical complaints were reinforced by findings of articular restrictions and tissue texture changes that had not subsided. Direct impedance of neurovascular flow was detected by means of palpation of hypertonic muscle bands and rubbery viscerosomatic reflexes.

Because the patient's symptoms persisted subsequent to receiving triple-antibiotic therapy, she had another consultation with a gastroenterologist. Upper endoscopy with biopsy, tissue culture, and susceptibility testing was performed. The biopsy results revealed changes in the atrophic mucosa, and *H pylori* cultures demonstrated resistance to clarithromycin and metronidazole and susceptibility to levofloxacin, tetracycline, and penicillin. However, the patient reported having hypersensitivity reactions to tetracycline, penicillin, and sulfa-based medications.

Approximately 6 weeks after the biopsy results were received, and after consultation with the US Centers for Disease Control and Prevention and specialists in gastroenterology and immunology/allergy, a quadruple-therapy regimen consisting of levofloxacin, bismuth subsalicylate, a PPI, and penicillin was devised, and the patient underwent desensitization to penicillin. She tolerated both the desensitization procedure and the 24-day quadruple-therapy regimen. Secondary to the complications associated with her condition and the previously observed atrophic changes, biopsy was performed to confirm eradication of *H pylori*. Biopsy specimens were obtained from 16 tissue sites. The medication regimen was continued until all biopsy specimens were found negative for *H pylori*.

After completing the quadruple-therapy regimen, the patient had resolution of thoracic pain and a 90% reduction in headache severity. The daily use of a PPI was gradually tapered until she required only occasional use of over-the-counter means of acid suppression, depending on her eating and drinking habits and her stress load.

At the time the present review was written, the patient no longer had symptoms of midthoracic nonneutral mechanics; the effects of neural tropism did not appear to be laced within hypertonic tissue; and occipitomastoid restriction, if present, was mild. The patient continued to have a propensity for C2 vertebra extension with sidebending and rotation to the right, as well as occipitoatlantal joint sideslipping to the left.

Relevance of the Case

The present case demonstrates that, through application of an enhanced palpatory skill set, the practice of osteopathic medicine can aid in the accurate diagnosis of gastritis. Awareness of the mechanisms behind viscerosomatic reflexes, segmental facilitation, and the convergence-projection model provide diagnostic clues regarding the widespread manifestation of this condition. Recognition of tissue texture changes and the quality of motion within segmental restriction provides a clinical means of assessing the progress of the patient's health. Excessive elasticity within the myofascial layers, accompanied by a rubbery articular end-feel, appears to be associated with viscerosomatic changes. When using OMT, the osteopathic physician may find that an activating force feels rubbery and that joint mobilization is unsuccessful when applied. These findings are most commonly encountered in association with thoracic and occipitoatlantal somatic dysfunction.

Findings of somatic dysfunction allow the osteopathic physician to monitor the progress of the patient's health. The return of segmental restriction, as well as the quality of changes within the related tissues, may indicate either a poor response to treatment or a possible relapse.

In a disease state, cranial dysfunction appears to manifest with a dense, hard, articular restriction. As a behavioral treatment regimen is adopted, as OMT is applied, and as healing progresses, improvement in the patient's condition can be determined through recognition of a greater sense of fluidity or a more spongy texture beneath the periosteum during osteopathic palpatory assessment. This improvement can also be perceived within the bony relationships along the sutures.

Osteopathic palpation not only was essential to the diagnosis of gastritis in the patient described in the present case report, but it also provided vital clinical clues regarding the patient's progression toward improved health. The use of unique, palpatory information as part of an osteopathic approach to clinical medicine, in com-

bination with established, evidence-based standards of care, appears to provide a level of patient care that can supersede conventional approaches.

Comment

Gastrointestinal disease is highly prevalent among patients who are frequently seen in the clinical setting. The presentation of a gastric insult may be forthright, easily preempting diagnosis and treatment initiation. When symptoms are less suggestive, however, a profound diagnostic advantage can be provided by osteopathic manual assessment. This advantage is exemplified in clinical practice by recognition of headache and thoracic pain as a primary complaint associated with gastrointestinal illness. This association may involve a relationship with the vagus nerve, the projection-convergence model (in light of a history of injury), or the physiologic properties of *H pylori* infection.

The usual strategies for diagnosing *H pylori* infection include the urea breath test, stool antigen testing, histologic evaluation of biopsy specimens obtained by endoscopy, and serologic testing for *H pylori* antibodies. The traditional urea breath test, which has a sensitivity and specificity of more than 90%, and the ^{13}C-urea breath test, which involves a collection card read by a compact analyzer, can be used in the outpatient clinical setting.[31] Stool antigen testing involves the use of an enzyme immunoassay to localize the *H pylori* antigen in stool specimens. The accuracy of such testing has had a sensitivity of 94% and a specificity that has ranged from 86% to 92%.[32] This test is also useful for follow-up evaluation of patients who have undergone treatment. Histologic evaluation of a biopsy specimen remains the reference standard for the accurate diagnosis of *H pylori* infection and associated conditions.[31] Serologic testing is an inexpensive and initial diagnostic option; however, the clinician needs to remember that *H pylori* antibodies may remain detectable for many years after active infection, a fact that highlights the importance of careful clinical interpretation of test results.

Because *H pylori* infections have a long duration, are prevalent worldwide, and are potentially associated with gastric cancers and lymphoma, antibiotic resistance is a growing concern. In addition, formidable dangers stem from the failure of a patient to comply with the therapeutic regimen and from the genetically diverse nature of *H pylori*. Furthermore, the literature suggests that patients with *H pylori* infection and type 2 diabetes mellitus have lower rates of *H pylori* eradication and higher rates of clarithromycin resistance than patients with *H pylori* infection who do not have diabetes mellitus.[33]

Clinical evidence supports the finding that eradication of *H pylori* improves the symptoms of gastritis and decreases the frequency of relapses of gastric and duodenal ulcers.[34] Considerable variability exists, however, regarding recommendations for standard first-line, second-line, third-line, and fourth-line treatment regimens for patients with *H pylori* infection, and decisions regarding the choice of treatment regimen can be further complicated when patients have drug hypersensitivities. The general consensus is to include first-line to third-line regimens consisting of double to quadruple therapy and involving combinations of such key antibiotics as amoxicillin, clarithromycin, levofloxacin, metronidazole, and tetracycline, in combination with a PPI and bismuth subsalicylate.[35] An 80% to 90% rate of success in eradicating *H pylori* has been associated with the use of first-line treatment regimens consisting of 2 antibiotics, such as amoxicillin and metronidazole (500 mg of each twice daily for 10 days), and a PPI twice daily with bismuth subsalicylate.[31]

If first-line therapy fails, levofloxacin (250 mg twice daily) may be combined with amoxicillin or metronidazole and extended for a 14-day course of treatment, in combination with the PPI and bismuth subsalicylate.[31] Subsequent suggested rescue therapies include the use of rifabutin or furazolidone, with emphasis placed on conducting susceptibility testing when available.[36]

Thus, when symptomatic colonization with *H pylori*

is present, the standard of care traditionally warrants the use of antibiotic therapy along with varied use of bismuth subsalicylate, a PPI, or some other medication. Blaser,[37] however, speculated that the prevalence of gastroesophageal reflux disease will increase with the disappearance of *H pylori*.[37] An inverse relationship between the presence of *H pylori* and Barrett esophagus has also been documented.[38] This information may charge physicians with the obligation of performing a risk-benefit assessment before pursuing *H pylori* eradication.

The present review of the literature and the accompanying case report validate the need for additional clinical research that may allow clinicians to correlate the findings of osteopathic palpatory assessment with current diagnoses. Efforts toward this undertaking have recently been explored by Licciardone et al,[39] in relation to type 2 diabetes mellitus. Further discourse on the existence of a symbiotic relationship, as opposed to a commensal or parasitic relationship, between the human body and *H pylori* needs to be explored.

Retrospective evaluation of the case report included in the present review may lead to the criticism that more frequent use of OMT during the medication phase of treatment may have bolstered the patient's immune response. Osteopathic manipulative treatment was applied at each office visit on the basis of symptom response. An expanded functional approach to rehabilitation may have provided the patient with additional substrates for healing. The present case report affirms that the osteopathic medical profession is built on a philosophy, body of knowledge, and advanced palpatory skill set that provide cost-effective diagnosis, treatment, and monitoring of disease states within the paradigm of prioritizing patient health care.

Conclusion

Headache and thoracic pain are underused components of a patient's subjective history that can aid in the diagnosis of gastrointestinal disease. Osteopathic structural evaluation assists in diagnosing gastrointestinal disease and in monitoring the patient's condition, whereas OMT palliates symptoms during the treatment phase. When the health of a patient with gastritis fails to improve after treatment is received, *H pylori* colonization and antibiotic resistance should be considered.

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