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An osteopathic approach to the renal and urinary system

Brian E. Kaufman, DO

From the University of New England College of Osteopathic Medicine, Biddeford, ME and H. Goodall Hospital, Sanford ME.

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This article reviews the anatomy, physiology, and pathophysiology of the renal and urinary systems. The clinically relevant interactions and contributions with the musculoskeletal system of interest and use to the osteopathic family physician will be discussed, and an osteopathic manipulative approach to the renal and urinary systems will be explored.

Introduction

Very little has been written about the osteopathic approach to renal and urinary issues. Many osteopathic physicians feel that the renal system is the realm of the specialist and our eyes glaze over at the mention of countercurrent multipliers, juxtaglomerular apparatus, and renal tubular acidosis.

In fact, many of the clinical dilemmas we face daily in our clinical practices involve the kidneys or related structures. In addition, there are many ways to use osteopathic thinking and practice that do not require advanced technical expertise or knowledge (ie, you do not have to be the osteopathic guru we all remember from medical school) to benefit our patients.

This article will address the overall approach and thought process by which the osteopathic family physician (OFP) may better understand the contribution of musculoskeletal physiology to the renal/urinary system, and practical ways to construct a rationally based treatment plan that could include the use of osteopathic manipulation as a viable treatment modality. The final section will review the osteopathic approach to several common diagnoses.

This article will use a model of musculoskeletal medicine to simplify the discussion. The somatic system can be broken into five pathophysiological elements: (1) Structural, (2) neurologic, (3) respiratory-circulatory, (4) metabolic-energetic, and (5) behavioral (See Figure 1). Although there is considerable overlap between the different elements, reducing the somatic system this way facilitates easier discussion, and the different elements can be treated with differing approaches.[1]

The kidneys are responsible for many physiological functions throughout the body. Acid-base balance in conjunction with the lungs, electrolyte balance, volume regulation, osmolality of the blood, erythropoietin secretion, and vitamin D metabolism are the main functions of the kidneys. Many common clinical conditions that the OFP encounters daily such as acute kidney injury, acute tubular necrosis, pyelonephritis, nephrolithiasis, chronic kidney disease, hypertension, acute infectious cystitis, and urinary incontinence involve the renal or urinary system. Other clinical disorders such as heart failure, myocardial infarction, sepsis, and malnutrition can affect renal function by altering volume and blood flow.[2] In addition, problems such as chronic interstitial cystitis and some urinary incontinence can be extremely challenging to treat using the best available conventional methods. Both patients and physicians can become frustrated by the lack of effective treatment options and this can lead to both patient and physician dissatisfaction.[3]

Corresponding author: Brian E. Kaufman, DO, University of New England College of Osteopathic Medicine, Stella Maris Hall, 11 Hills Beach Road, Biddeford, ME 04005.
E-mail address: osteodoc02@yahoo.com

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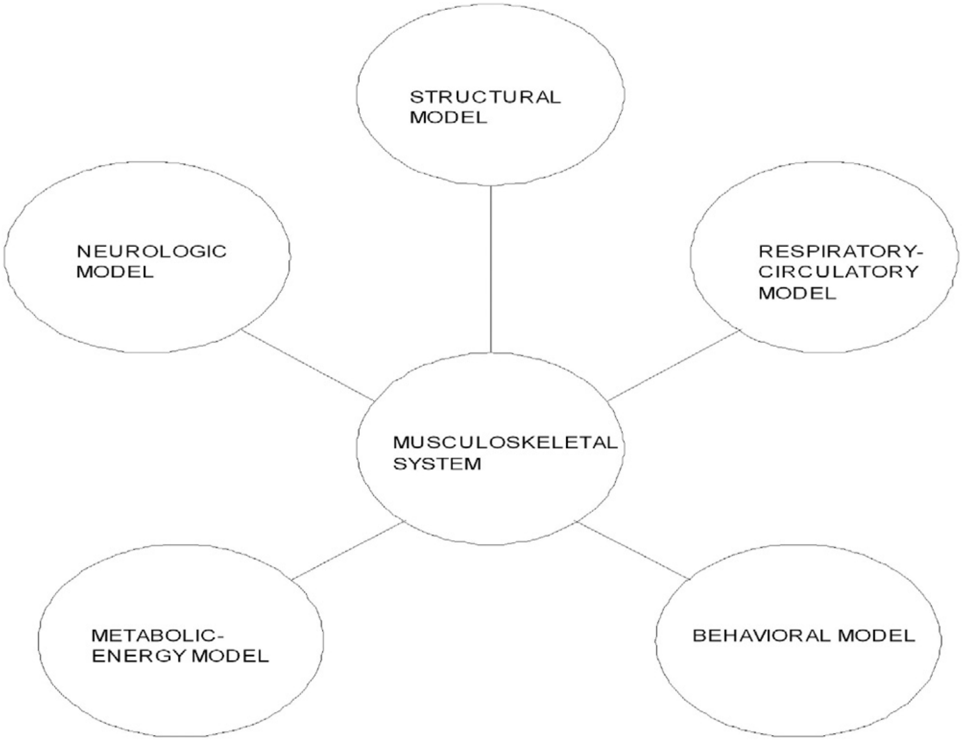

Figure 1 Model of aspects of musculoskeletal medicine.

Many drugs and medical interventions can have deleterious effects on the renal system. Nonsteroidal anti-inflammatory drug (NSAID) use is extremely common but can cause acute nephropathy, acute interstitial nephritis, and chronic kidney disease, and it can worsen hypertension. Computed tomography scan and cardiac catheterization contrasts can both cause acute kidney injury. Despite the many excellent standard medical treatments available, there are a myriad of clinical cases that can benefit from non-pharmacologic treatment. These are the situations in which the OFP can use osteopathic medicine to treat their patients.

Biological, physiological, pathophysiological, and clinical data will be cited to support an osteopathic approach whenever possible. However, it should be noted that there are few randomized clinical trials that have examined this subject. Therefore, biological and pathophysiological models, in the context of accepted osteopathic experience, will be used to support this approach.

Structural elements

Musculoskeletal changes can affect renal function either directly or through changes in cardiopulmonary function.

The kidneys are located in the retroperitoneal space between T12 and L3 and are about 10 cm in size.[4]

The kidneys are supported only by fascial connections through the renal fat. The primary attachment is through the diaphragmatic fascia as well as the psoas major fascia. The lower aspect of the renal fascia is in contact with the quadratus lumborum muscle (Figure 2).[4]

Both the lateral and medial lumbocostal arches cross posterior to, and are in contact with, the kidneys. The arches are in turn connected to rib 12. Lateral traction on the twelfth ribs can provide tension on the arches and thereby affect the kidneys, ureter, and fascial structures.[5] The kidneys are associated with the diaphragm and the pleura superiorly, psoas and quadratus lumborum muscles inferiorly, and peritoneum anteriorly, and they lie deep to ribs 11 and 12. Therefore, we can take advantage of the psoas and quadratus lumborum muscles to affect changes directly or we can use the relationship with the diaphragm to affect changes more indirectly (See Figure 3).

The subcostal nerve, iliohypogastric nerve, and the ilioinguinal nerves cross the kidneys posteriorly, and irritation of surrounding structures can lead to irritation of these nerves, which can cause some of the typical renal pain syndromes.[6]

The ureters travel along the course of the psoas muscle and are attached via the psoas fascia. The psoas in turn attaches to the lesser tubercle of the femur. Using the femur as a handle onto the psoas muscle, the practitioner can alter the tone in the ureter, decrease smooth muscle spasm, and assist the passage of stones. For example, if the femur is flexed and externally rotated, psoas muscle tone and ureter tone are decreased. This may aid in decreasing pain and allow a stone to pass easier over the pelvic brim and into the bladder (See Figure 4).

The bladder sits in the pelvic cavity, which is an osseous container with a muscular floor. The muscular floor is made up of the pelvic diaphragm, which not only supports pelvic structures but aids in structural integrity of the external urethral sphincter. The bladder is attached via the pubove-

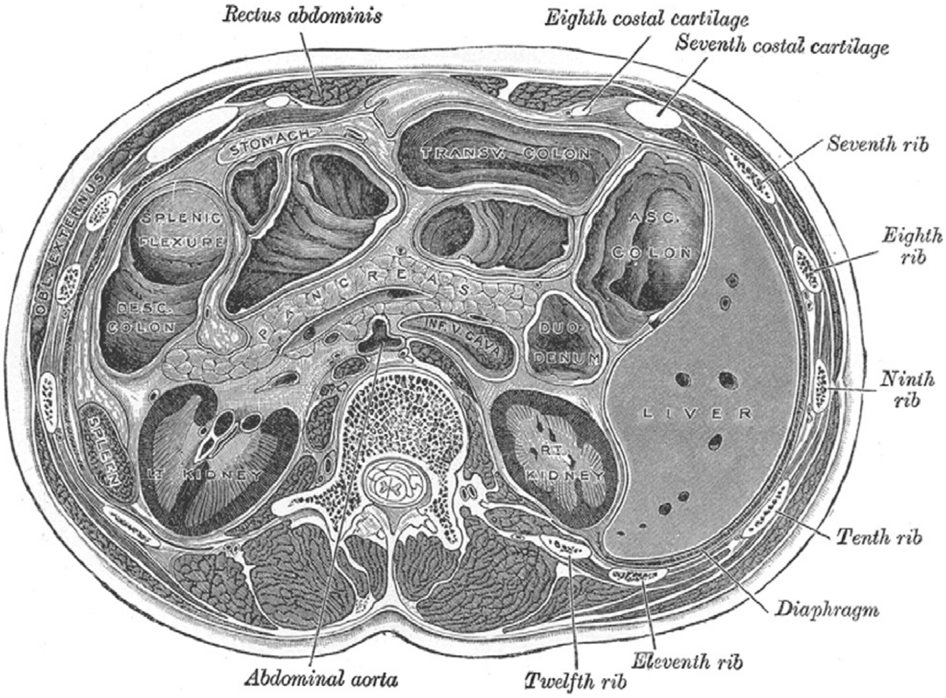

Figure 2 Transverse section illustrating kidney attachments and relationships.

sicular and puboprostatic ligaments; otherwise it is free in the pelvis (See Figure 5).[4]

Urinary continence is maintained by contraction of the sphincter musculature. This is assisted by the urogenital diaphragm. Pubic shear, pubic/pelvic counterstrain tender points, pelvic diaphragm trigger points, and innominate and sacral somatic dysfunction can lead to pelvic shape and tone changes, which can torque the urogenital diaphragm and lead to incontinence. By treating these findings with manipulation and affecting the structural mechanics, as well as normalizing muscular tone, we can help restore optimal function.[7]

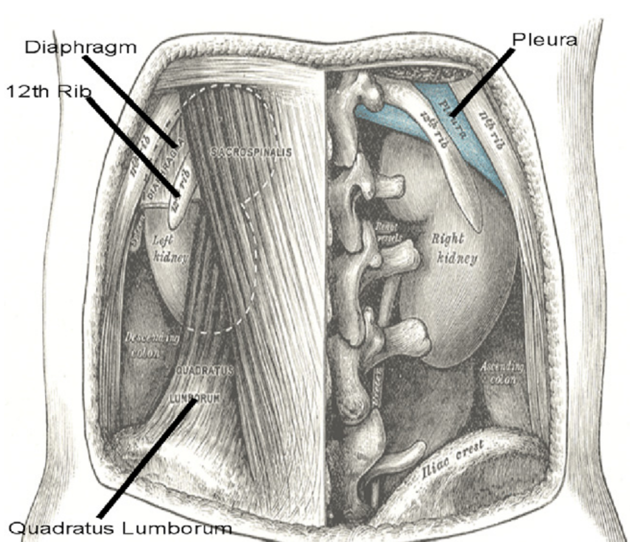

Figure 3 Posterior aspect of kidney anatomical relationships.

During thoracic inhalation, the diaphragms contract and the spinal curves flatten. The base of the sacrum moves posterior and the overall shape of the thoracoabdominal-pelvic cylinder changes. These changes in shape create pressure changes in the thorax and abdomen throughout respiration.

During inhalation, the kidneys move inferiorly along the psoas muscle. The superior aspect moves anteriorly and the entire kidney rotates externally. The bladder follows the motion of the sacrum and moves both superiorly and posteriorly. The ureters will follow the motion between the kidneys and bladder.

Like all structures in the body, the kidneys are designed to move and travel 3 to 4 cm on average with each breath. Multiply this by the conservative estimate of 17,000 breaths per day and the kidneys have traveled more than 600 m! This illustrates the principle that healthy function is dependent on motion.

The pelvic diaphragm contracts and expands during the respiratory cycle. The pumping action of the pelvic diaphragm aids in the movement of venous and lymphatic fluids. Somatic dysfunction can alter the excursion of pelvic diaphragm contraction and lead to stasis of lymph and venous blood in the pelvis. This leads to pelvic congestion, pain syndromes, and an inability to clear infections adequately.[8]

Visceral manipulation practitioners use techniques that address the kidneys and bladder directly through indirect myofascial unwinding. It is reported that these techniques can help restore proper motion and function.

Neurological elements

The majority of regulation of kidney function occurs through endocrine and autonomic mechanisms. Most of

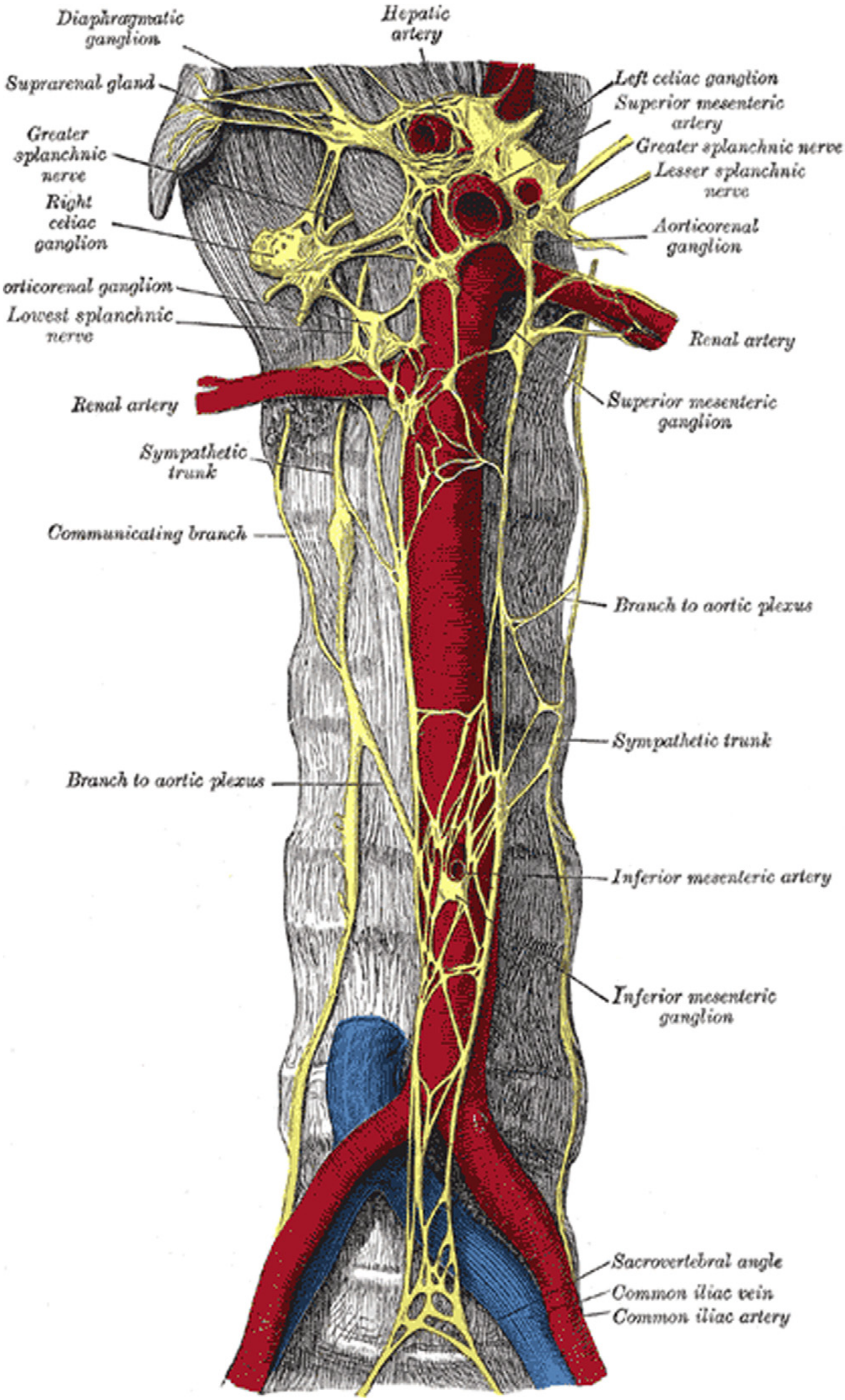

Figure 4 Kidney, bladder and nervous system.

the autonomic innervation to the kidneys is through the sympathetic system from fibers that originate from T10-T12. Sympathetic nervous system stimulation to the kidneys causes vasoconstriction of the afferent arterioles, which decreases glomerular filtration rate and results in decreased urinary output.[9]

Subject to the presence of increased sympathetic tone and resultant endocrine changes, the kidney will undergo remod-

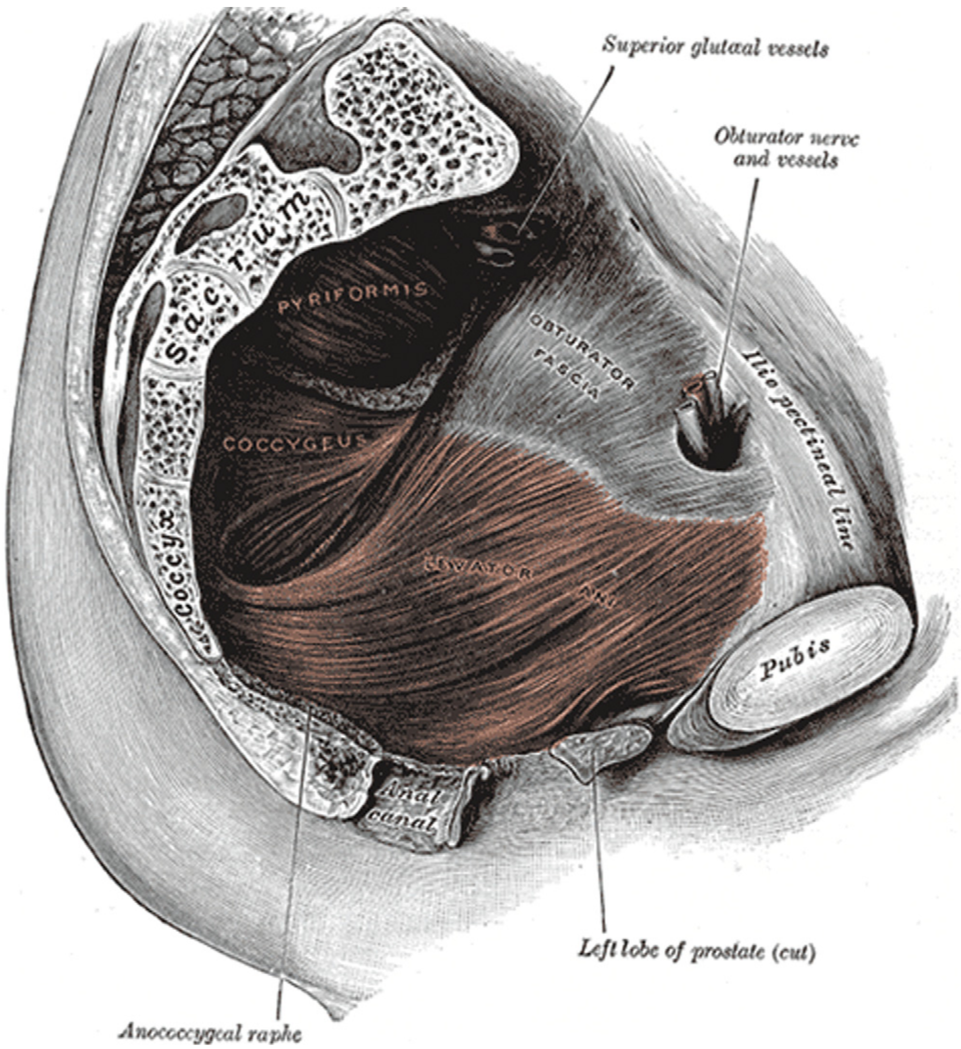

Figure 5 Superior view of pelvic "bowl" and hemi-pelvis.

eling changes similar to the myocardium after myocardial infarction or heart failure. Hypersympathetic stimulation to the kidneys has also been postulated to play a role in the genesis and etiology of essential hypertension through chronic vasoconstriction and sodium resorption.[10]

Increased sympathetic stimulation to the ureters from fibers originating from T10-L2 decreases ureteral peristalsis and can lead to spasm. This can cause a visceral pain syndrome but can also cause psoas spasm. This has been implicated in restricting the passage of kidney stones. Treating somatic dysfunction at these levels may help relax ureteral spasm through somatovisceral reflexes and allow stone passage.[11] High velocity low amplitude, strain-counterstrain, muscle energy, or any osteopathic technique can be used as long as it addresses somatic dysfunction at the affected levels. This is why choice of technique may not be as important as the application, and is how different practitioners can achieve similar goals using very different techniques with differing proficiency.

Visceral afferent nerves from the bladder wall transmit to both L1-L2 and S2-S4 and are intimately involved in a complex interaction with the autonomic nervous system in the process of urination. Voluntary relaxation of the external urethral sphincter and decreased sympathetic tone are simultaneously required. In addition, there must be relaxation of the internal urethral sphincter, which occurs through a parasympathetic reflex from S2-4.

When our patients are in pain, anxious, or otherwise affected, a complicated series of metabolic and autonomic changes occur, which can lead to urinary retention and incontinence.[12,13] Osteopathic treatment can improve autonomic balance and thus lead to improved function.[14,15] Acute viscerosomatic reflex or segmental facilitation is characterized by warmth, muscle spasm, tenderness, and moisture. These are explained by the physiological processes of vasodilation, reflex stimulation of alpha motorneurons in the deep back musculature, activation of the inflammatory cascade, and vasomotor activation, respectively. These are the basic findings that characterize somatic dysfunctions.[16]

Korr et al.[17] performed experiments in the 1950s to document interaction between somatic tone and viscerosomatic influence. These somatovisceral reflexes can feed back to the target viscera. This provides a clear rationale for osteopathic manipulation of spinal elements, with the goal of affecting neurologic tone to a target visceral organ. This allows the OFP to treat patients with nephrolithiasis, pyelonephritis, ureteral spasm, bladder spasm, and hypertension (HTN) from a neurological perspective.

There have been several studies on the relationship of HTN to osteopathic medicine. Johnston et al.[18] reported in 1995 the prevalence of a segmental dysfunction pattern associated with HTN. They reported finding a pattern of dysfunction at C2, T2, and T6.

Another study treated hypertensive patients with osteopathic manipulation and measured serum aldosterone levels. Although no change in blood pressure measurements were recorded, there was a statistically significant drop in aldosterone levels 36 hours post-treatment that was not seen in the sham treatment group. This might demonstrate the phenomenon of alteration in autonomic tone.[19]

Respiratory-circulatory elements

From the macroscopic perspective, the respiratory-circulatory model views the movement of blood and lymph throughout the body. From the microscopic view, we focus on the exchange of oxygen and nutrients and removal of metabolic waste products at a cellular level.

The thoracic-abdominal-pelvic cylinder encases the viscera. Pressure gradients are created by motion of the thoracic and pelvic diaphragms. During inhalation, the thoracic diaphragm will contract, flatten, and move downward; the pelvic diaphragm also moves downward. During exhalation, the pelvic diaphragm returns to an elevated position and the thoracic diaphragm retains its typical shape. This pumping action occurs during each breath and creates gradients that not only create air movement but help move lymphatic fluid and venous blood more along their course.[20]

During times of inflammation or obstruction, renal lymphatic flow can increase significantly, which helps explain why during processes that create hydronephrosis, renal function does not necessarily become impaired.[21] By treating thoracic-ribcage-abdominal and pelvic somatic dysfunctions, the effectiveness and efficiency of pressure gradients, and hence the body's ability to assist in lymphatic and venous fluid return, is improved.[22]

There are significant endocrine factors that affect both circulation and function. Angiotensin 2 constricts both the afferent and efferent arterioles but preferentially increases efferent arteriole resistance. During conditions of increased angiotensin 2, prostaglandins play the dominant role in vasodilation of the afferent arteriole. The kidneys receive approximately 25% of cardiac output during normal functioning and this can change significantly based on cardiac and pulmonary dynamics. These hormones allow for maintenance of renal blood flow and regulate urine production based on perceived needs of the body. In addition, it is important to keep in mind that many of our patients may be on angiotensin-converting enzyme inhibitors or angiotensin receptor blockers and are therefore prostaglandin-dependent for regulation of renal blood flow. Many of our patients taking these medications are also taking NSAIDs and other prostaglandin blockers for pain, headache, etc. This combination can precipitate acute kidney injury, as well as lead to chronic kidney disease through chronic hypoperfusion of the kidneys over time. OFPs have a role in treating patients' pain and associated issues in a nonpharmacologic manner, because this can reduce the likelihood of these pathologies.

During states of hypoperfusion to the kidney or perceived hypoperfusion (decreased effective circulating volume, decreased renal blood flow through mechanism as mentioned before), the body attempts to preserve volume status. Antidiuretic hormone is released and causes resorption of free water along with aldosterone, which causes sodium retention at the expense of potassium. Under conditions in which blood volume is not diminished, this can lead to fluid overload. Patients can experience pulmonary edema, ascites and peripheral edema, and these in turn can lead to hypoxemia, hypercarbia, cellulitis, etc. It is during these conditions that lymphatic drainage must increase to accommodate reabsorption of third spaced fluids.

There are no medications that address the lymphatic system directly; only musculoskeletal medicine has this ability. Treatment is directed first at the thoracic inlet. The thoracic duct must pass twice through the thoracic inlet to drain lymph back into the venous circulation. Somatic dysfunction in this region can affect the efficiency and capacity of lymph drainage. Once "the drain" has been opened, the thoracic spine, rib cage, and diaphragm can be treated.[23] Abdominal and pelvic somatic dysfunction should be treated next. Finally, lymphatic pumps can be used to mobilize fluids once these treatments have been completed.[24]

Metabolic/energetic elements

Fatigue can be a major symptom of patients with renal disease.[25] As previously stated, the kidneys receive approximately 25% of cardiac output. They are partially responsible for elimination of waste products of metabolism, acid-base balance, formation of blood, electrolyte balance, and vitamin D metabolism. Any one of these essential processes can become disrupted by kidney disease. As kidney function declines, the ability of the kidneys to perform these tasks diminishes. Anemia, subtherapeutic vitamin D levels, increases in blood urea nitrogen, and electrolyte imbalance can occur with either elevated levels or depleted levels of electrolytes. Acidosis can occur if hydrogen ions are not able to be excreted effectively. Any of these changes can lead to a change in a patient's strength and energy.

The acidotic patient has an increased respiratory rate for compensation. This stresses the body, and any underlying somatic dysfunction will be exaggerated. Add underlying anemia and increasing blood urea nitrogen and the effect can worsen. These patients consume more resources to maintain homeostasis and therefore fewer resources are available to maintain well-being and perform activities of daily living. Patients may complain of fatigue, pain, swelling, or dyspnea.[25]

Allostatic load is the total summation of all the stressors on a patient. These stressors can be physical, metabolic, emotional, and musculoskeletal. This is mediated through the hypothalamic-pituitary axis. Hypersympathetic states along with elevated cortisol and neuroendocrine levels occur. These changes in our immune status have consequences regarding life expectancy, morbidity, and pathology.[26]

The osteopathic family practitioner cannot only treat the underlying disease process but can also address somatic dysfunction and thereby improve efficiency of the musculoskeletal system and decrease overall allostatic load. This can help preserve patients' resources and affect the ability of our patients to both maintain quality of life and improve overall well-being. This can be true even in less obvious cases.

Behavioral elements

In osteopathic medicine we are trained to look at the person as a unity of body, mind, and spirit.[27] Changes in emotional states have well-documented psychological impact on the body at large. This has been demonstrated through the concept of allostatic load, which has been written about previously.[28] Through these mechanisms, emotional stress can cause vasoconstriction of renal blood flow and this leads to decreased urine production and output. This in turn can lead to the changes listed previously.

Studies have examined the relationship between renal disease and depression and have found increased prevalence of depression in patients even in the early stages of kidney disease.[29] The prevalence of depression in patients with kidney disease is higher than that for other chronic diseases such as diabetes, heart failure, and coronary artery disease.[30] Research has shown that as much as 40% of patients with chronic kidney disease and 50% of patients with end-stage renal disease have major depression. Patients with depression and kidney disease have higher morbidity and overall worse outcomes.[25]

Depression can have both somatic and cognitive features that mimic the findings of uremia—anorexia, sleep disturbances, abdominal pain other pain issues, and fatigue.

Unfortunately, there are very few studies that examine treating these patients with pharmacologic agents and essentially no studies examining the use of manipulation in these patients for the purpose of improving depression symptoms.

The OFP has a role to intervene that may include screening (you cannot treat what you have not found!), pharmacologic intervention, and the use of osteopathic manipulation.

Through the use of osteopathic medicine and manipulation, the practitioner is able to decrease somatic dysfunction throughout the body and decrease both segmental and central facilitation, thereby decreasing the musculoskeletal contribution to the allostatic load. In addition, the autonomic milieu can change from one of hypersympathetic state to parasympathetic state, which has many documented positive benefits.

There have been a few pilot studies that examined the treatment of depression using manipulation, and these have shown a positive effect in treated patients.[31] Although there is a paucity of randomized, controlled trials, there is at least this evidence and pathophysiological rationale to include osteopathic treatment as a possible intervention to offer these patients.

Examples of disease-based treatments and rationale

It should be stressed that the OFP will treat the findings that are present and not rely on patterns and expected findings. The actual techniques used will vary based on practitioner preference and skill level; however, some of the most powerful techniques are also some of the simplest. In addition, it should be noted that manipulation is an excellent adjunct and complements the armamentarium of pharmacologic and other treatments available to physicians. Also, there are many times when nonpharmacological treatment can avoid many of the side effects encountered with the use of medications.

Hypertension

Hypertension is thought to be a condition involving hypersympathetic tone, causing vasoconstriction of the kidneys, which results in sodium retention. Treatment would be aimed at reducing any somatovisceral reflexes that may be affecting renal physiology, improving lymphatic and venous drainage through the use of the approach outlined in the respiratory circulatory model, and identifying and treating any pain issues that would cause patient to be using NSAIDs.

Nephrolithiasis

Nephrolithiasis can cause significant sympathetic response, which is often exhibited by diaphoresis and tachycardia, as well as elevated blood pressure. There is also an acute segmental response that causes decreased ureteral peristalsis, which inhibits the passage of stones. There is significant pain involved with stone passage and this is exhibited by paraspinal hypertonicity and segmental somatic dysfunction. This in turn can lead to somatovisceral reflexes that feed back into spasm of the ureter. By decreasing somatic dysfunction, the practitioner may be able to decrease sympathetic tone overall, and decrease viscerosomatic activity and somatic visceral reflex activity, which inhibit stone passage.

Hydroureter/hydronephrosis

These pathologies result in local fluid overload and stasis of fluids. Identification of the cause of these is paramount. In addition, osteopathic medicine can be used to enhance treatment. In a case of fluid stasis, there is decreased lymphatic drainage from the area in question. There may be a situation in which overproduction of the lymph in the area caused by increased osmotic forces outproduces the ability to drain lymph from the area under normal circumstances. The OFP should use the respiratory-circulatory principles to enhance drainage. Treatment would be directed at maximizing efficiency of lymph drainage through the procedure outlined above. Lymph pumps can be used to facilitate drainage and improve function of local structures.

Cystitis

Whether it is acute or chronic interstitial cystitis, treatment should be aimed at improving motion of the bladder and supporting structures. Specific attention should be addressed to any pubic dysfunction that may be affecting ligamentous attachments to the bladder or fascial relationships in the pelvis. Acute cystitis is typically accompanied by edema in the area of infection. Improving motion of the pelvic diaphragm and restoring pressure gradients will improve drainage, help normalize urogenital diaphragm tone and sphincter function, and decrease symptoms.

In terms of chronic interstitial cystitis, it would be important to address respiratory circulatory concerns as well as any neurological concerns (viscerosomatic and somatovisceral reflexes to the bladder and pelvis) and structural findings. Practitioners with experience can address the bladder directly using visceral manipulation.

Conclusions

This article was written for the Osteopathic Family practitioner and has been organized according to the model of 5 integrated elements of musculoskeletal medicine. It is for the practitioners who fight in the frontline trenches of medicine. We all have success stories that we relish and the patients we helped, but there are other patients whose problems keep us awake at night. It is precisely those patients who benefit from the use of osteopathic medicine in terms of thinking, understanding, and practice.

The musculoskeletal system is mysterious, perplexing and complicated. It is unique in that it offers us a variety of ways to practice and multiple techniques from which to choose to help our patients and access their pathologies from a hands-on perspective. Studying the complexities of musculoskeletal medicine can take a lifetime, however the typical OFP already has the tools and expertise to help their patients through the use of osteopathic manipulation and medicine. Understanding the complexities of musculoskeletal medicine can be a study of a lifetime; however, the typical OFP has the tools and expertise to help their patients through osteopathic medicine and manipulation.

By using these tools and knowledge, the OFP may be able to improve a patient's well-being and outcomes beyond pharmacological and interventional resources. This can also be personally satisfying in our practice. Through this approach we demonstrate the highest level of our science and art as practicing physicians and achieve the greatest good for our patients.

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