Referred Pain

As adapted to veterinary medicine

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NO ASPECT of Veterinary Medicine offers a greater challenge to the clinician or practitioner than the rendering of an accurate and complete diagnosis. Unquestionably the greatest service that can be rendered a client is an accurate, complete diagnosis—for without diagnosis there can be no rational treatment or control of disease. Therefore, the clinician is ever mindful of aids in diagnosis.

Nervous Reflexes in Diagnosis

In the past the clinician has been concerned with nervous symptoms and reflexes only inasmuch as they involve the central nervous system. In this paper, I shall attempt to associate nervous reflexes as they concern or relate to internal pathology. Diagnosis of pathological conditions of the visceral organs, indeed, presents a challenge in accurate diagnosis. Therefore let us consider and utilize nervous reflexes as aids in diagnosis of visceral pathology of the thorax and abdomen.

The method to be presented is based upon the method of Clavier. This method utilizes nervous flexes in order to arrive at a diagnosis. The method of "Clavier" seeks to bring visceral radiations to the periphery, and to make the exterior the mirror of the interior. Human neurologists have made comprehensive and detailed anatomical studies of the nervous system, and are using this knowledge in arriving at more accurate and complete diagnoses. For example, the exact location of brain tumors is quite often determined by studying and correctly interpreting nervous reflexes and radiations. In the field of veterinary medicine lies a fertile field for the research worker who is interested in neurology as related to clinical diagnostic procedures. The reader must bear in mind that only a limited amount of work has been done in regard to referred pain as it relates to pathological conditions. It is the hope of the writer that this paper will stimulate thought and interest in the possibilities of using referred pain reflexes as an aid in diagnosis. Therefore, let us look forward to scientific research of the future which may disclose and more adequately explain the relationship of referred pain to clinical diagnosis than is possible at the present time, and that it will find a wider application in Veterinary Medicine.

It is not necessary to know precisely the anatomy and physiology of the nervous centers in order to utilize the method of Clavier. It is sufficient to simply know the zones of the radiations of the vagus and of the sympathetic. Vegetative life is the function of the automatic nervous system which comprises the vagus and the sympathetic. In the normal state the vegetative life is subconscious. We do not feel the beat of our heart nor the functioning of our stomach or intestine. In the pathologic state it is not the same. The injured viscera demand assistance for the superior nerve centers, and it is the purpose of this paper to intercept the signals of distress.

Nervous System

Before presenting the method of Clavier, let us briefly outline the entire nervous system and review the anatomy of the spinal nerves as they relate to peripheral manifestations of reflectivity. The nerv-

ous system of the animal body may be briefly outlined as follows:

I. Central Nervous System
   A. Brain
   B. Spinal Cord

II. Peripheral Nervous System
   A. Cranial and Spinal Nerves and their ganglia
   B. Autonomic Nervous System
      1. Sympathetic nerves—originating from the thoraco-lumbar area by way of rami communicantes.
      2. Parasympathetic nerves—originating from the 3rd, 7th, 9th, and 10th cranial nerves; and from the sacral area.

Because the nerves of the thoracic, lumbar and sacral regions are so closely associated with the method of Clavier, we shall next review in detail the course followed by these nerves and observe the structures innervated by them. I feel that to appreciate the method of Clavier it is imperative that the anatomy of these nerves be reviewed in some detail. There was a question in the mind of the writer as to whether an anatomical discussion of these nerves should be included in this paper, or if the reader should be referred to this anatomical material elsewhere. However, I felt that it would be more convenient for the reader if this material be included in this paper so that it might be conveniently referred to if desired. I hope the reader will bear with me on this discussion of anatomy which I feel should be reviewed in order to better appreciate the material to be presented later. Therefore, let us proceed to discuss the spinal nerves of the thorax, lumbar, sacral and coccygeal region.

The Thoracic Nerves[1]

The thoracic nerves number eighteen on either side of the horse. They are designated numerically according to the vertebrae behind which they emerge. Each divides into a *dorsal* and *ventral branch,* the latter being the larger.

The *dorsal branches* emerge behind the levatores costarum and divide into medial and lateral branches. The medial branches ascend on the multifidus and supply the dorsal spinal muscles. The lateral branches run outward under the longissimus dorsi and emerge between that muscle and the longissimus costarum; after giving twigs to these muscles they pass through the latissimus dorsi and the lumbo-dorsal fascia and ramify as dorsal cutaneous nerves under the skin of the back. In the region of the withers they give branches to the serratus dorsalis and rhomboideus, and their cutaneous terminals pass through these muscles and the dorso-scapular ligament to supply the skin over the ligamentum nuchae and the trapezius muscle. It must be remembered that these dorsal branches carry sensory fibers that terminate mainly in the skin, and motor fibers terminating in the muscles innervated.

Intercostal Nerves

The *ventral branches* or *intercostal nerves* are much larger than the dorsal branches, and are connected with the sympathetic by rami communicantes. The first thoracic ventral branch goes almost entirely to the brachial plexus, but sends a smaller branch downwards in the first intercostal space which is expended in the muscle there without reaching the lower end of the space. The second ventral branch furnishes a considerable root to the brachial plexus, but its intercostal continuation is typical. The intercostal nerves descend in the intercostal spaces with the vessels of like name, at first between the intercostal muscles, but lower down they are chiefly subpleural. In the anterior intercostal spaces the artery lies along the posterior border of the rib, with the nerve in front of the rib; further back the nerve lies behind the border of the rib, with the artery in front of it. These intercostal nerves supply the intercostal muscles and give off lateral perforating branches. The second to the sixth inclusive emerge through the spaces between the costal cartilages and concur in supplying the pectoral muscles. The second to the eighth give branches to the transversus thoracis. The succeeding ones give branches to the diaphragm, pass between the transverse and internal oblique abdominal muscles, give twigs to these, and

end in the rectus abdominis. There are three series of cutaneous nerves given off by the intercostal nerves. The dorsal series emerge through the latissimus dorsi and the lumbo-dorsal fascia parallel with the lateral border of the longissimus. The middle ones perforate the serratus ventralis, external intercostals, and external oblique. The ventral series appear through the abdominal tunic. These intercostal nerves and their subsequent branches carry motor fibers to muscle, and sensory fibers to sensitive structures like the skin, pleura, and peritoneum. The posterior three ventral branches supply in part of the skin of the flank. The ventral branch of the last thoracic nerve runs outward behind the last rib across the dorsal surface of the psoas major and divides into superficial and deep branches. The superficial branch passes over the superficial face of the transversus abdominis, perforates the oblique externus, and ramifies under the skin of the flank. The deep branch descends on the deep face of the internal oblique to the rectus abdominis in which it ends.

The Lumbar Nerves[2]

There are six pairs of lumbar nerves in the horse, the last of which emerge between the last lumbar vertebra and the sacrum. The anterior two or three are about the same size as the thoracic nerves, but the others are much larger. Their *dorsal* branches are small in comparison with the ventral ones, and are distributed to the muscles and skin of the loins and croup in a fashion similar to those of the thoracic nerves. The *ventral* branches are connected with the sympathetic by small rami communicantes and give branches to the sublumbar muscles.

The ventral branch of the first lumbar nerve is termed the *iliohypogastric nerve.* It passes outward between the quadratus lumborum and the psoas major and divides at the lateral border of the latter into a superficial and deep branch. The superficial or cutaneous branch passes over the dorsal edge of the internal oblique, descends between that muscle and the external oblique, perforates the latter, and runs downward and backward and ramifies under the skin of the posterior part of the flank and lateral surface of the thigh. It gives branches to the transversus and obliquus abdominis externus. The deep branch is smaller; it runs downward and backward beneath the peritoneum to the lateral border of the rectus abdominis, gives branches to the internal oblique, and terminates in the rectus abdominis.

Second Lumbar Nerve

The ventral branch of the second lumbar nerve is usually connected by an anastomotic branch with that of the third nerve. It gives off a large branch to the psoas major and is continued as the *ilio-inguinal nerve.* This nerve divides like the iliohypgastric into superficial and deep branches. Its *superficial branch* perforates the external oblique muscle a little in front of the point of the hip, runs downward on the front of the thigh and the lateral surface of the stifle, and gives off cutaneous branches. The *deep branch* runs behind and parallel with that of the ilio-hypogastricus and detaches branches to the abdominal muscles. It joins a branch of the external spermatic nerve, and the trunk so formed descends the inguinal canal, to be distributed to the external genital organs and the surrounding skin in the inguinal region.

The ventral branch of the third lumbar nerve is connected by a small anastomotic branch with the second nerve and furnishes a root of the lumbo-sacral plexus. It gives off a branch to the psoas muscles, the external spermatic nerve, and is continued as the lateral cutaneous nerve. The *external spermatic nerve* passes backward in the substance of the psoas minor and divides into two branches. One of these, the muscular branch, emerges in front of the circumflex iliac vessels and goes to the cremaster and internal oblique muscles. The other, the inguinal branch, emerges behind the vessels just mentioned. It then runs lateral to and parallel with the external iliac artery and descends in the medial part of the inguinal canal. It emerges at the external ring with the external pudic artery and ramifies in the

(Continued on page 219)

Referred pain

(Continued from page 211)

external genital organs and the skin of the inguinal region. The *lateral cutaneous nerve* of the thigh runs backward in the substance of the psoas muscles and emerges at the lateral border of the psoas minor. It then passes outward and backward on the iliac fascia and accompanies the posterior branch of the circumflex iliac artery. With this vessel it perforates the abdominal wall by passing between the external oblique and the iliacus a short distance below the point of the hip, descends on the medial face of the tensor fascia latae, and ramifies subcutaneously in the region of the stifle.

The ventral branches of the fourth, fifth, and sixth lumbar nerves concur in the formation of the lumbo-sacral plexus—which gives rise to nerve trunks which traverse and supply the entire leg and gluteal region with motor and sensory nerve fibers as well as sympathetic fibers to blood vessels.

The Sacral Nerves[3]

Five pairs of sacral nerves are present in the horse. The small *dorsal branches* emerge through the dorsal formina and the space between the sacrum and the first coccygeal vertebra, and ramify in the muscles and skin of the sacral region and the adjacent part of the tail. The fifth anastomoses with the dorsal branch of the first coccygeal nerve.

The *ventral branches* leave the vertebral canal through the ventral sacral foramina and the interval between the sacrum and the first coccygeal vertebra. They are connected with the sympathetic by rami communicantes and contribute branches to the pelvic plexus. The first and second nerves are the largest, and they unite with each other and with those of the last three lumbar nerves to form the lumbo-sacral plexus. The third and fourth are connected with each other, and the majority of their fibers go to form the pudic and posterior haemorrhoidal nerves.

The *pudic nerve* passes downward and backward partly embedded in the sacro-sciatic ligament, then accompanies the internal pudic artery to the ischial arch, turns around the latter, parting company with the artery, and pursues a flexuous course along the dorsum penis as the *nervus dorsalis penis* and ramifies in the glans penis and the penile layer of the prepuce. Within the pelvis it anastomoses with the posterior haemorrhoidal nerve, and gives branches to the bladder and urethra, the terminal part of the rectum, and the skin and muscles of the anus. It also supplies the nerve to the ischio-cavernosus muscle and numerous branches to the corpus cavernosum of the penis and urethra. In the female it terminates in the clitoris and vulva.

The *posterior haemorrhoidal* nerve passes downward and backward above the pudic nerve, with which it anastomoses. It gives twigs to the terminal part of the rectum, the sphincter ani externus, and the surrounding skin. In the female it supplies twigs to the vulva also.

The ventral branch of the fifth nerve is small. It gives twigs to the sacro-coccygeus ventralis lateralis and the skin of the root of the tail and joins the first coccygeal nerve.

The Coccygeal Nerves[4]

The coccygeal nerves commonly number five pairs. Their dorsal and ventral branches anastomose to form respectively two trunks on either side, which extend to the tip of the tail and supplies its muscular and cutaneous nerves. The dorsal trunk runs with the dorso-lateral artery between the sacro-coccygeus dorsalis and inter-transversales muscles. The ventral trunk accompanies the ventro-lateral artery below the intertransversales.

From the fact of its anastomosis with the spinal accessory, the vagus transmits its irritation to the level of the brachio-cephadicus and of the trapezius; the vagal irritation passes in other words through the brachial plexus and furnishes the extensor muscles of the elbow, consequently with responses having the same significance as those of the brachiochephalicus. The anastomosis of the vagus with the inferior cervical gangion records some painful manifestations.

The sympathetic of the thorax, abdo-

men and pelvis is represented by a series of ganglia in number equal to those of the vertebrae except at the level of the shoulder where there are two ganglia, sometimes three. Each of these ganglia is reunited to an intercostal nerve or to its homologue by the rami communicantes, going over the paths over which pass the fibers which go to and come from the viscera. Each intercostal nerve or its homologue is therefore in relation with some visceral fibers, and according to the origin of the fibers one considers the existence of peripheral zones which receive fibers from a group of viscera. It is thus that the first five intercostal nerves are in relation with the organs innervated by the thoracic plexus comprising the heart, lungs, vessels and pleura. From the sixth to the ninth intercostal nerves one finds the anterior solar plexus which supplies the stomach, liver, spleen, pancreas, duodenum; from the ninth to the twelfth intercostal nerves we have the posterior solar plexus in relation which comprises the small intestine, caecum, and first half of the colon loop; from the twelfth to fifteenth intercostal nerves we find the anterior mesenteric plexus which innervates the second half of the colon loop; from the fifteenth to eighteenth intercostal nerves we find a relation with the renoaortic plexus or posterior mesenteric plexus. The organs innervated by the pelvic plexus include the uterus, bladder, ovary, colon and rectum. Pain from these organs is reflected to the surface at the level of the lumbar veterbrae and of the flank. Thus we have associated the various plexuses of the thoracic and abdominal wall which is to serve as a mirror to internal pathology in the aforementioned organs. We shall search the zones outlined for clues of distress in the internal visceral organs in an attempt to render a complete, accurate diagnosis of the organ or organs involved.

Irradiations

According to the law of "report to the periphery" one may understand the irradiations from a distance. This law says that the irritation arriving at the cord by a peripheral nerve is as if it had come from the extremity of that nerve. This law explains that those with amputated limbs complain of pains in the removed segments; that those with coxaliga suffer from the knee; those with prostatitis suffer from the urinary meatus. We also interpret as consequences of the report from the periphery; erection in coprostases or calculus; the movement or carrying of the head toward the inguinal region or toward the thigh in the case of ectopia of the pelvic loop of the colon into the pelvic cavity; the sinking of the head of the horse attacked with sablose (sand colic).

Let us now consider some of the manifestations to be observed in the zones outlined in both the normal and pathological states.

Pathway of the Back

In the normal state, the pathway of the back is only active at the level of the lumbar region. The brachiocephalicus and the elbow muscles are more or less active, as is the thoraco-abdominal covering of muscle. One is familiar with the fact that the lower part of the flank is active, and that the upper part of the flank is passive in regard to reflex activity.

In the pathological state, the phenomena which one may meet may be grouped under the following heads: Diffuse hyperreflectivity, general hyporeflectivity, acitvity of the passive zones in the normal state, and hyperactivity of the active zones in the normal state. It is desirable to always explore comparatively the symmetrical regions. One may find the right brachiocephalicus less active and the left brachiocephalicus hyperactive. One concludes in this case that the dominant vagus is the left. Diffuse hyperreflectivity on the part of a patient indicates the presence of a neurosis. One may readily determine presence of neurosis by exploration of the superior border of the neck. Any horse which, excluding all irritation of external origin, reacts to exploration of the neck is neurotic. Such horses have lost control of their reflexes, and must be handled with extreme caution for their movements are unpredictable.

Hyporeflectivity is met with in subjects in which the vegetative tonus is feeble.

These cases have insufficient endocrine functioning. Subjects in the crisis of a disease may also present a hyporeflectivity. General hypotonicity in the course of crisis may or may not be accompanied by malignant syndrome. When malignant syndrome exists which is characterized by haggard eyes, weak filiform pulse and cold sweats, the hour of diagnosis is past. The practitioner is no longer able to make an absolute diagnosis. In the absence of malignant syndrome, the generalized hyporeflectivity reveals subjects which have a sluggish, slow, lazy vegetative life. In such cases, excitants render the greater service in treatment.

In cases where there are some passive zones which have become active or where the active zones have become hyperactive, diagnosis by the method of Clavier is easy. One makes at first sight a diagnosis of the sector, then a diagnosis of the organ. To facilitate easy determination of sectors or zones, a line which passes from the summit of the withers perpendicular to the ground separates the thoracic plexus from the abdominal plexuses; and the line tangent to the last rib separates the abdominal and pelvic plexuses.

Correlation

In order to incriminate a zone or sector, there must be a summarizing and a correlating of all diagnostic helps. One must not rely upon reflex activity of a sector alone. Such valuable diagnostic helps as percussion and auscultation should also bear out and substantiate the sector you have incriminated based upon reflex irritability. The zone or sector will have to be carefully sought for in many cases for it may not be evident on initial observation of the patient. The clinician may note sweating in certain sectors which will provide evidence for incriminating a certain sector. More commonly, the zone or sector will be incriminated only after thorough palpation of the entire neck, thorax and abdomen for the detection of pain. Often this palpation may have to be more vigorous than palpation by hand alone, and will require use of a blunt instrument. Practice in this procedure will quite often disclose areas of the thorax and abdomen which demonstrate referred pain to a marked degree as compared with adjacent areas. Thus far we have laid the basis for the method of Clavier which utilizes referred pain as an aid in diagnosis. Let us conclude this paper by demonstrating its application to specific cases.

Gastric Disorders

Should we find a reflective brachiocephalicus dominant on the left side and an anterior solar plexus dominant on the left side, we incriminate the anterior solar plexus and particularly the stomach and the spleen which are projected to the left. Clinically it is always necessary to think of the more frequent cases. If one considers this principle, he is well toward the conclusion that he is dealing with a stomach trouble. However, it is also necessary to find several gastric symptoms, that is to say, several manifestations such as yawning, cribbing, nausea, or belching, to substantiate your conviction of a gastric disorder. History of repeated contusions, produced in the course of a profound narcosis in horses after a heavy meal, are followed by disturbances of which the foregoing are outstanding.

In the case of calculus of the small colon, one may be confused by observing reflectivity affecting the anterior mesenteric plexus (twelfth to fifteenth intercostals) when the offending foreign body lies in the territory of the posterior mesenteric plexus (fifteenth to eighteenth intercostals). This discrepancy can be satisfactorily explained by the fact that the intestine, in many cases, suffers more from the obstruction than does the small colon. Thus we are confronted with an incriminating reflectivity of the anterior mesenteric plexus. It may be the question of volvulus, or coprostasis, or of calculus of the terminal portion of the great colon. However, the behavior of the patient eliminates the question of volvulus, as the pain manifest wasn't continuous or as profound as observed in volvulus. The diagnosis of caprostasis will not be retained because auscultation permits the notation that instead of the silence of intestinal aphonia that one observes in stasis, there is an intense borborygmus which is intense

rumbling or gurgling sounds produced by the intestines. There remains the hypothesis of a calculus of the fourth portion of the colon. If this diagnosis were correct, we would not be able to feel the calculus on rectal examination. Therefore, we detect the presence of the calculus on rectal examination and come to consider the diagnosis of calculus of the small colon. Auscultation has shown us that the tract was free as far as the floating colon. Therefore, it is not a question of caprostasis, nor of volvulus, nor of calculus of the terminal part of the great colon. There is no other diagnosis to make than that of an obstacle at the level of the floating colon.

Internal Parasites

We know that the parasites of the digestive apparatus are quartered in certain areas of the gastro-intestinal tract. It is thus that Gastrophilus larvae are found in the stomach; that the Ascaridae live in the small intestine; the Stongylidae, the Cyclostomes and the Oxyguridae live in the colon. Each time the method of Clavier accuses one of these digestive segments, one may ask if it is a question of troubles due to parasites. The absence of reflexes permits the elimination of the existence of a parasitic affection. Strongylidae and Cyclostomes are found especially in the colic loops which are projected to the right of the abdomen, and the Oxyuridae in the loops which are found on the left. In considering these facts, one may say with great chances of truth that a reflex dyssymmetry of the abdomen in favor of the right side is due to Strongylidae, and a dyssymmetry in favor of the left side is due to the presence of Oxyuridae. Bilateral abdominal hyperreflectivity is very often due to the existence of both Strongylidae and Oxyuridae.

The method of Clavier has been applied to the diagnosis of colics, to consultation in purchase of horses, to obstetrics and gynecology, to vegetative tonus, and to parasitic infestation. The reader of this paper must keep in mind that the method of Clavier is only an aid to diagnosis. Movements, the attitudes, the study of physiological deviations, the law of fluctuation and the law of the relation of physical signs with functional signs all have their importance in this difficult operation which constitutes diagnosis. The matter of diagnosis has been approached from many different avenues of thought and study. Each scientific method of approach has shed some light on this difficult operation of making an accurate and complete diagnosis. The findings and method of Clavier is an approach from an avenue that has been too frequently bypassed. Interception and interpretation of the signals of distress, as conveyed by the nervous system of the body has already been utilized by human physicians as an aid in diagnosis. The relationship of referred pain to internal pathology is an unexplored field from which immense riches wait to be harvested. Let us look forward with open minds for developments in the field of neurology that we may open up an additional and new avenues to this perplexing challenge which constitutes an accurate and complete diagnosis.

REFERENCE

1, 2, 3, 4. *The Anatomy of the Domestic Animals* by Sisson and Grossman.

Talcum powder used on rubber gloves to prevent adhesion of surfaces during sterilization and to facilitate putting them on the surgeon's hands has long been recognized as a hazard in abdominal surgery causing foreign body peritonitis, post-operative intraperitoneal adhesions and recurrent intestinal obstruction. That talc used on surgeons' gloves is frequently deposited in the abdominal cavity in laparotomies despite washing the gloves and other precautions was shown by an investigation that revealed residual talc in 80 per cent of those who had undergone an operation in which the abdominal cavity was opened. Seeling, Verda and Kidd experimented with a large number of substances as substitutes for talcum powder in the sterilization and use of surgeons' gloves and found only one, potassium bitartrate (cream of tartar) that possesses all of the advantages and none of the disadvantages of talc.