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Somatic Sensory Impulses and Vertebral Lesions

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THE place of conscious sensations in the diagnosis and in the perpetuation of the effects of vertebral lesions has long been recognized. The fact that the visceral sensory impulses are never, or only rarely, conscious has been somewhat neglected in the consideration of the place of the bony lesion in pathogenesis.

Conscious sensations due to vertebral lesions may be either extremely faint, or even almost absent, or they may be intensely vivid and productive of most acute discomfort. The depth of the conscious effects depends, probably, upon several very different factors: The anatomical relations of the subluxated bones; the nature of the edematous effects due to the lesion; the liminal value of the sensory neurons of the first or higher orders; the emotional characteristics of the individual suffering from the lesion, and other considerations of even more indirect relationships.

Some considerations of the sensory relations may be, very briefly, reviewed for the sake of clearness. The value of sensory impulses in the preservation of

life is usually underestimated. In order that the body may react to its environment efficiently, it is necessary that the environment must affect the body in such a way as to bring about efficient motor reactions. In other words, the body cannot make adequate reply to environmental changes unless these changes propound the questions. And the body must appreciate these environmental demands -- not, of course, consciously, but not any the less adequately so far as the possibility of reaction is concerned. The sensory nervous system provides for this necessity; it is the vehicle by means of which the vertebrate body is enabled to transform environmental changes into motor stimuli. It is the accumulator of facts, upon which the motor system acts, either directly or after the co-ordinating processes of the cerebral activities.

In the case of the human being, sensory impulses are extremely complicated. The lower spinal centers may receive sensory impulses and transform their effects into motor impulses, very simply, and the effects of the activities of these

centers in determining the effects of the bony lesion has long been recognized. More complicated conditions are found in the intimate relations between the different spinal levels, whereby the sensory impulses entering any one spinal segment are enabled to act upon the centers of adjacent segments, perhaps for six or more segments upward and for four or more segments downward. Since different centers vary in liminal value from one another, and in themselves from day to day, or hour to hour, the effects of any one lesion are not to be adequately predicated.

The sensory neurons of the first order are those which are first affected. Their cell bodies lie in the intervertebral sensory ganglia, about thirty-one pairs in all; there are usually two or three vestigial or rudimentary pairs of coccygeal ganglia. They receive their blood supply from adjacent vessels, and their circulation is controlled from sympathetic ganglia of the same or adjacent segments. It is thus evident that the circulation through any given sensory ganglion is subject to modification as the result of lesions affecting the vertebrae of the same or adjacent segments. By means of this relationship lesions of the upper thoracic vertebrae cause the brachial neuralgia or the brachial neuritis with which so many osteopathic physicians have so painful an acquaintance. For they, as the result of too constant unvaried action of the arms and shoulders very often suffer from upper thoracic lesions, and simultaneously from the results of over-work of the upper thoracic and lower cervical centers; the sensory ganglia suffer congestions, the brachial plexus and all its related nerve trunks also suffer congestions, and the ultimate effects are both painful and disabling.

The somatic sensory peripheral, neurons whose bodies lie in the intervertebral ganglia send out two processes; one is physiologically dendritic, and it passes to the end-organs in the skin, muscles and joint surfaces of the same or adjacent segments of the body—that

is, those structures which were embryologically derived from the same metameres. Only to a slight extent do the somatic sensory neurons supply the body cavities. The visceral sensory neurons send similar processes, usually by way of the sympathetic nerve trunks, to the viscera and related structures.

Somatic sensory end organs in the skin include those affected normally by heat, cold, touch, pain, and certain other factors less commonly recognized. Under ordinary circumstances the heat nerves are stimulated by heat above body temperature; the cold nerves, by heat below the body temperature. Since no human experience includes the total lack of heat, and since the sensations initiated by increased heat and by diminished heat appear in consciousness to be qualitatively different, it follows that while these sensations may be very useful in human welfare, they are not capable of giving accurate information. Water at 98.6 degrees seems very hot to a bather, just out of the ocean; but seems very cold to a feverish patient. Stimulation of the optic nerves or centers by any means gives sensations of light; stimulation of the nerves of special sense by any means gives the sensations characteristic of that sense; in the case of color, it seems unquestionably true that variations in color are merely variations in tempo, yet our sensations are of a qualitative difference, as in blue and red, for example; in the case of sugar and of saccharine, essentially very different, we find a similar taste; sugar and starch, essentially very similar, give us very different tastes; in no case do our sensations give accurate information. It appears evident, then, that sensory impulses have as their duty not the giving of scientific facts, but the control of the motor activities in such a way as to preserve and perpetuate life.

The processes from the sensory neurons of the first order divide a short distance from the cell body, the peripheral, prolongation, which has been mentioned, going to the end organs, and the other passing into the spinal cord, forming, for the most part, its posterior roots. Enter-

ing the cord, these axons divide again, one branch passing upward in one of the long tracts, the other passing downward from one to four or more spinal segments. Each of these branches gives off numerous short collaterals which terminate among the cells of the spinal gray matter.

The fibers which enter the long tracts carry sensory impulses upward, to enter and thus to stimulate the nerve centers in the cerebellum, medulla, pons, mid-brain, thalamus, and, ultimately, the cerebral cortex. Probably none of the fibers of the posterior roots pass directly to the cortex, but the impulses from the peripheral neurons are once or twice or more relayed from neuron to neuron until the cortex is reached, and thus consciousness is affected. It must be remembered that these pathways are not simple, but that an enormous complexity of relation exists at every level from spinal segment to cerebral cortex, underlying the complexity of the reflex, instinctive, emotional and intelligent reactions possible for human beings in their relations with other human beings and with the world as a whole. It must be remembered also that consciousness is affected only in the activity of the extremest layer of the cerebral gray matter, and that the deeper layers of the cortex, the basal ganglia, the cerebellum, the pons, the medulla and the spinal centers all may offer crossings by means of which sensory impulses may initiate motor activities without the intermediation of consciousness, though consciousness may or may not be affected after the motor response has been determined, or has been completed. The higher the level of the sensori-motor relationship, the more complicated and the more intelligent, as a rule, are the responses made. There are a few real exceptions, and very many apparent exceptions, to this statement.

The spinal reflexes are immediate, are the reply to simple stimuli, are not coordinated further than the anatomical facts of spinal cell structure compels, and give single reply to single demand. Inasmuch as use modifies liminal values, there is some effect upon the spinal centers

affected which is somewhat more than transient.

Sensory impulses acting through the medulla, pons, and cerebellum are more complicated, usually rest upon several or a series of sensory impulses, act upon systems of muscles in several or many metameres, and produce movements of decidedly complex nature.

Sensory impulses acting through the mid-brain or basal centers are still more complicated, are affected emphatically by the history of the animal or the race, are usually associated with emotional qualities, with co-operating changes in the circulation, respiration, internal secretions, and activities of non-striated muscles, such as pilo-motors, etc.

Sensory impulses acting through the cortical neurons are subject to judgment and reason, these, again, being the result of a co-ordination of past experiences of the individual and of other individuals with whom he has been associated. The history of the entire universe, and the future as it may be anticipated by the study of the past, is at his service in the determination of the reply which is to be made in answer to his environmental changes. Sensory impulses, ultimately, are the basis of all this tremendous complexity of intelligence, just as the alphabet is at the basis of all books, but by the combining of one series as in the combining of the other, all knowledge and understanding and literature and science and art have been erected.

These primary considerations are essential to an understanding of the place of somatic sensory impulses in the after-effects of vertebral lesions. It must be thoroughly understood that in no sensory system of the body is there any adequate attempt to give information which is accurate, but that in every class of sensation, and in every sensory system the primary usefulness lies in the fact that sensations underlie motion; that the preservation and the perpetuation of life depend upon the power of the organism to make adequate response to environmental changes, and not upon the power of the organism to know the environment in any impersonal or scientific

sense, certainly not upon the power of the organism to know occurrences within his own body in any sense at all. Also, that it is upon this basis, crude and uncertain as it is, that all our mentality rests.

The effects of vertebral lesions may be considered as each of these levels may be affected. At any spinal segment, the vertebral lesion affects to some extent the joint surfaces, causing, in consciousness, either a vague and almost negligible sensation of strain, or a definite and severe pain.

The lesion affects the circulation through the sensory ganglia of the same and immediately neighboring segments, usually causing first a slight and temporary constriction, then a slight and more lasting dilation of the arterioles. Such a ganglion presents a very slightly redder appearance than does the normal ganglion. The liminal value of the neurons of the first class is lowered, so that stimuli arising from the skin, joint surfaces and muscles which are ordinarily sub-minimal are now able to initiate sensory impulses, while stimuli ordinarily able to initiate faint sensations are now distinctly strongly appreciated. Thus, as the result of the slight congestion of the ganglia, many sensations, as of restlessness, aching, prickling, formication, sharp pains, and vague discomforts, all referred to different parts of the body according to anatomical relations, appear in consciousness and affect the general mental state of the patient. All these sensations may be due to the slight congestion of the sensory ganglia, and this slight congestion is known to occur as the result of the lesion.

The congestion has other effects. Edema may appear; must appear if the congestion persists. The edema is associated with increased carbon-dioxid content of the intercellular fluids. This, in turn, together with the edema and its pressure factors, diminishes the passage of nerve impulses over nerve fibers. Diminished sensory impulses result; normal sensations fail to reach either the spinal centers, for the control of the viscera and maintenance of normal muscular tone;

the cerebellar and basal ganglia centers, for the control of complicated motions; or the cortical centers, for the adequate information of the individual concerning his body and its surroundings. Since the effects of the congestion, increasing the effects of stimuli; of edema, increasing or diminishing according to the degrees of pressure concerned; and of the carbon-dioxid tension, diminishing the passage of impulses through nerve trunks, all vary from minute to minute, it is evident that the result must be a somewhat uncomfortable mixture of increased, decreased and qualitatively modified sensations in consciousness, and modified visceral activities. These things are known to occur in vertebral lesions.

The edematous state of the connective tissues around the lesioned area together with edema of the muscles nearer the spinal column, add to the discomfort, since these tissues also are supplied with sensory nerve endings, and, while they may not be distinctly present in consciousness, they make up the back-ground of physical condition upon which more vivid pictures are thrown. Muscle tone, especially of the spinal muscles is also a part, distinctly an important part, of the back-ground of consciousness; we are not vividly conscious, but have a vague and certain feeling of the spinal column as erect and capable, or as flaccid and inefficient, or as uncomfortable or restless or painful in part or as a whole.

In the presence of vertebral lesions, considerable areas of the spinal musculature may be relaxed. A sense of general weakness or inefficiency may result; this, being not distinctly recognized, may be interpreted in consciousness as mental weakness or inefficiency, or lack of ambition, or inability to meet the demands of existence; and that individual may actually lose a considerable proportion of his ability to meet the demands of his daily life in this manner. Because of this spinal relaxation, he becomes, as he feels, inefficient. If he compels himself to meet his problems face to face, he may compel spinal contractions; these may lead either to perpetuation of the lesion, or, fortunately, to its correction.

In other cases, a local area of spinal contraction may be present. In these cases, again, the sensations may be negligible or severe. If severe, the pain may be pronounced and thus lead to early treatment, let us hope, by an efficient osteopathic physician. In a considerable proportion of cases, there is unlocalized or vaguely localized discomfort, with a sensation of tension and dull aching. This causes frequent movements of the affected area, and this, in turn, may lead to correction of the lesion, or to the formation of neighboring lesions, with associated increase in the severity of the symptoms.

Sometimes,—and this is not rare,—there is a sense of discomfort, not localized, and occasionally not even recognized as being spinal. The patient feels generally "out of fix,"—as indeed he is,—and attributes his discomfort to his surroundings. He is apt to "take it out" on his inferiors or his associates, and to fail to perform his proper duties. Being incorrectly related to his environment, he is apt to seek change of environment to seek some new position, which is, of course, subject to the same cause of distaste. There is a very real psychological effect to such conditions, and this should be recognized more clearly than it is at present.

The statements just made apply to vertebral lesions anywhere. In lesions of the upper thoracic and cervical region further complications arise. Lesions of the upper thoracic region may affect the circulation through the meninges of the skull, since the vaso-motors of these tissues arise from the rami communicantes of the upper thoracic region. The blood vessels of the meninges of the base of the skull, and those covering the cerebellum are very important factors in controlling pressure conditions within the skull. The basal ganglia and the pons, cerebellum and medulla are thus especially subject to the circulatory variations in the meninges. Thus, upper thoracic lesions may easily modify the activities of the nerve centers; imperfect co-

ordination of complex movements and disturbance in the emotional reactions are frequent associates of such lesions.

The circulation through the cerebral hemispheres is rather less subject to these circulatory variations, especially in adult life, on account of the anatomical conditions. Swelling of the nasal and pharyngeal mucous membrane may interfere with the lymphatic drainage; this is often due to cervical lesions. The cerebral meninges are subject to a certain amount of circulatory disturbance on account of the upper thoracic lesions, but they do not seem to be so speedily or so profoundly affected thereby as are the basal ganglia, which lie below the ventricles, and thus have considerable areas affected by meningeal foldings. The cerebral hemispheres do suffer, however, to some extent, from such lesions, and this suffering is sometimes rather serious, so that intellectual activities may be seriously modified. The most frequent effect of cervical lesions upon mentality, however, seems to be as an indirect result of the sensory and the basal-ganglia disturbances, rather as a direct effect upon the cerebral hemispheres. The congestion of the meninges is a very common cause of headache, and this may affect mental activities profoundly.

The indirect effects of vertebral lesions upon somatic sensory impulses and conscious sensations are almost unending. The disturbances in the secretions of the thyroid gland, due to cervical or upper thoracic lesions; the effects of ovarian congestion; the effects of disturbances in the supra-renals, the modifications in other internal secretions due to vertebral lesions need only to be mentioned in order to receive due tribute. The effects produced in consciousness by the presence of traces of bile in the blood serum, itself due to lesions of the mid-thoracic spinal column; the sensations associated with disturbed action of the heart, of the stomach, of any other viscus, which may be adversely affected by vertebral lesions, arouse symptoms of pain and dis-

comfort which vary from the most intense suffering to slightest malaise.

The psychological effects which follow the presence of slight cerebral edema, due to vertebral lesions and disturbed meningeal circulation; the delayed communications resulting from the accumulation of carbon dioxide in edematous areas; the irritation of the nerve centers of the cerebrum due to imperfect circulatory states

in the skull and the retention of katabolites as the result of imperfect venous or lymphatic drainage, the effects of irritating sensory impulses from the spinal centers, and the emotional disturbances associated with these states, are yet unstudied. Their importance and significance we can only vaguely estimate.

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