Sympathetic Segmental Disturbances-II

The Evidence of the Association, in Dissected Cadavers, of Visceral Disease with Vertebral Deformities of the Spine of the Same Sympathetic Segments.

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The object of these necropathies was to determine whether any connection existed between minor curvatures of the spine, on one hand, and diseased organs, on the other; or whether the two were entirely independent of each other. The material came from the Laboratory of Operative Surgery on the cadaver, in the University of Pennsylvania, which is in no way responsible for the reductions drawn. In all fifty bodies were examined: the anterior thoracic and abdominal wall removed; the anterior surfaces of the bodies (centra) of the vertebrae were cleared so as to have them distinctly visible. The organs were examined. Notes were then taken in two columns. The first column contains descriptions of the organs that were found diseased; the second column contains descriptions of the curvatures found. When the diseased organs and the vertebrae in curvature belonged to the same sympathetic segments, the notes on each were placed opposite each other in two columns. When the diseased organs were not of the same sympathetic segment as the vertebrae in curvature, the notes on each were placed on different levels, case for case. It could be seen at a glance whether the diseases found were at the same sympathetic segmental levels as the vertebrae which were parts of the curvatures, or whether the diseased organs belonged to different sympathetic segments than from the vertebrae which were out of line. Unfortunately, through lack of space, the complete anatomic descriptions have been omitted, and only the tables, which will shortly follow, retained. Forty nine of the fifty cadavers showed undoubted minor curvatures. The one exception had a slight smooth lateral curve in the thoracic region (such a curve has been considered normal by many). The very minor visceral pathology of this body (No. 12 in the omitted report) was in the segments immediately above or below the reported curve, in other words, it belonged to the segments which should form the compensatory curves had such been reported. All curves and deformities of the spine were rigid, apparently of long duration; irreducible by ordinary manual force: extension, counter-extension, rotation, even strong lateral movements failed to remove them or even cause them to change their relative positions. Except that the attachments of the vertebrae and the intervertebral discs were still preserved, the curvatures did not differ substantially from those seen in skeletons. Minor curvatures differ from the grosser curves of the Orthopedic surgeon only in degree, and in that their association with disease of organs belonging to the same sympathetic segment is more frequent than with gross curvatures. Of the four gross curvatures (two of Pott's disease and two with gross lateral curves), diseased organs were not found to belong to the same sympathetic segments as the gross curvatures, but were of the same sympathetic segments as the minor curvature (compensatory curves above and below the greater curves). 1

In the tables which follow of the fifty cadavers examined, consecutively: column one contains the names of the organs which were diseased; column two contains the vertebrae in numerical order which were in the curve and belonged to the same sympathetic segment as the diseased organs in column one; column three contains those vertebrae in curvature which did not belong precisely to the same sympathetic segment as the diseased organs in column one, but to slightly different segments therefrom; column four shows the sympathetic supply for each of the organs in column one; column five is a kind of check system to find the relative frequency with which the pathology is found in the organs belonging to the same sympathetic segment as the vertebrae in the curve. Statistics such as these are reliable, provided that all exceptions are tabulated as well as the rules. If all data

Therefore, in fifty cadavers with disease in 139 organs, there was found curve of the vertebrae, belonging to the same sympathetic segments as the diseased organs 128 times, leaving apparent discrepancy of ten, in which the vertebrae in the curve belonged to an adjacent segment to that which should supply the diseased organs with sympathetic filaments. However, the nerve filaments entering the cord or leaving travel or have traveled up or down the cord a few segments, accounting for all of the apparent discrepancies. The check amounts to 138, when the one body No. 12, which had a faint curve, with slight pathology only, is added we have the original 139, showing that the figures are fairly accurate.

The following disease were found, taken in their order from neck to feet: **Larynx** cancer 1, **thymus**, large and fatty 2, **pleurae**, adherent 24, effusion 2, **lungs**, pneumonia 15, tuberculosis 9, edema 7, passive congestion 5, fibrous lung 1, bronchitis 4, enlarged peribronchial lymph node 1, influenza 5, **heart**, endocarditis 3, dilatation 10, brown degeneration of heart muscle 1, pericarditis 2, aortic aneurysm 1, **liver**, hypertrophic cirrhosis 4, atrophic cirrhosis 3, fatty cirrhosis 3, cirrhosis 1, congested 1, cloudy swelling 1, gall stones 5 times, **stomach**, dilated 4, ulcer 1, tumors 1, hemorrhage 1 or 2, spleen, large 7, atrophic 5, perisplenitis 1, **pancreas**, degenerated 1, **kidneys**, large red 8, small red 7, acute parenchymatous 2, cystic 1, cloudy swelling 1, **appendicitis** 1 or 2, combined with salpingitis, **uterus** displaced and adherent 1, **prostatic** hypertrophy 4, atrophy 3, **urinary bladder**, ribbed 4, cystitis 1, tumors 1, unduly large 1, small 1, **groin**, wound of excision of cancer or buboe 1, hydrocele 1, osteomyelitis tibia 1. In general, were found the ordinary diseases of adult life.

The original observations, omitted through lack of space, are now re-examined, as a check system on the tables, for discrepancies. Fifty cadavers exhibited a total of 105 curvatures, two of which showed Pott's disease, two gross scoliosis, leaving 100 minor pathological curves. Of these, 96 showed evidence of disorders (diseases) in some of the structures supplied by that portion of the sympathetic system coming from the vertebral segments in curvature. There were nine curvatures without any evidence of disease in the organs belonging to the same sympathetic segment as the vertebrae in curve. As four of these were gross curves (Pott's disease or gross scoliosis) five minor curves are left, without disease in the organs supplied by the same part of the sympathetic as the vertebrae in the curve. Reversing the process of thought, 221 structures other than the spine were found diseased. Of these, 212 were observed to belong to the same sympathetic segment as the vertebrae in curvature. Nine diseased organs belonged to different sympathetic segments than the vertebrae out of line. These figures cannot be expected to exactly coincide with those in the tables, for an organ may receive sympathetic filaments from several spinal segments, and several organs may be supplied with sympathetic filaments from the same spinal segments.

In no instance was a complete sympathetic block observed. In other words, when and where the vertebrae were found in curvature, never were all of the organs found to be diseased which belonged to the same sympathetic segment as the vertebrae out of line. We can compare this fact with the irritation of somatic nerves observed in spondylitis deformans or Pott's disease. Partial pressure on cord or nerves producing partial; paralysis only. The sympathetic system, being composed of nerve cells and fibers, like the cerebrospinal and peripheral nerves, being merely a part of the rest of the nervous system (with perhaps more gray rami), we can expect that irritation near the origin of the sympathetic system will cause functional or organic changes in the organs supplied by that portion of the sympathetic nervous system irritated in the same manner as irritation of the peripheral nerve (somatic nerve) near its origin will cause functional or gross pathological changes in the structures to which the nerve is distributed. If Raynaud's disease, symmetrical gangrene, can be due to "vaso-motor spasm" 2 or to "anatomical changes

Rheumatoid arthritis was found several times on the anterior sacro-iliac ligament combined with evidences of the so-called sacro-iliac subluxation, such as apparent shortening of the limb, comparative elevation of the of the posterior superior spine of the ilium, and approximation of the latter to the middle line, combined with lateral curve of the lumbar region , lumbar curve and sacro-iliac subluxation (rotation of the innominate) appear to be interdependent. The conversion of the anterior sacro-iliac ligament into bone is but another example of nature's method of immobilization of diseased joints, the inflammatory process going to the point of least resistance, exostoses occurring where muscles and ligaments have undergone excessive strain, thus pulling the bone into excessive tuberosities. 18 The stages in the process appear to be: 1, minor curvatures or so-called sacro-iliac subluxations; 2, the muscles are converted into ligaments, ligaments into bone. Finally the bony ankylosis occurs. The disease appears to precede old age and to cause it. The spine becomes stiff first and old age follows. Therefore, we may say that a man is as old as his spine, the arteries becoming hardened later from constant vaso-motor spasm, following sympathetic irritation.

Another example of direct pressure upon, or infection of, the sympathetic system is found in pleural adhesions. Pleural adhesions were observed 26 times in 42 bodies associated with minor curves in the upper dorsal region in all but two instances; the lungs were diseased in 19 of the 26, the heart in 6. On the other hand, there were 7 instances of the lung and 14 instances of heart disease in which the pleurae were not mentioned. Pleurisy is common clinically without, as well as with, disease of the lung. Pneumonia without pleurisy was demonstrated in a few times in the 50 bodies. The pain over pneumonia, as well as other organs, is now believed to be in the coverings, or even in the chest wall or abdominal wall, the organs themselves being comparatively insensitive. When the lungs were pulled out of the cadavers, the adhesions were sufficiently strong to pull the intercostal vessels and nerves from their grooves under the ribs; the sympathetic can also be pulled upon in this manner. Pleurisy may be caused by infection, the earliest stage being hyperemia. 14 The irritation of the sympathetic is probably as much caused by the infection as by direct pressure; the reflex spasm of the vaso-motors deranging the blood-supply of the organs supplied by the sympathetic segment in the curve.

A simpler illustration, one more readily grasped, and easier to prove clinically, is the somatic disturbances associated with vertebral involvement. Of three cadavers with inguinal disturbances (bilateral hernia, hydrocele, idiopathic bubo or cancer, which had been excised in an old woman), all showed rotation of the twelfth dorsal vertebra; the connecting links being the ilio-inguinal and genitocrural nerves. Skin disease:- two cadavers with warts exhibited minor curvatures in the region from which the affected skin received its nerve supply. 15

Two dissections were made of the sympathetic origins, with vertebral column attached, tracing the sympathetic system from the minor curvatures to the blood supply of the organs diseased. One showed minor curvature in the upper dorsal region, in the neighborhood of the inferior cervical ganglia of the sympathetic, sclerosis of the carotid vessels, and softening of the frontal lobe of one side with atrophy of the brain, in an old woman. 16 [information on the other dissection was not clear enough to read and reprint] The vertebral columns of these two dissections were mobilized (made moveable), with the following observations: 1, Extension of the vertebral column stretched the sympathetic system; 2, flexion of the vertebral column relaxed the sympathetic system; 3, side-bending rotation of the vertebral column produced stretching (tenseness) of the sympathetic on the convex side of the curve, and relaxation of the sympathetic system on the concave side of the curve, of the vertebral column. By placing the thumb as the fulcrum of a lever behind the vertebral column, and pressing thereon, the movement of the vertebral column and the

proving and disproving are given equal consideration, there can be no deception. As an example, body No. 1 of the omitted necropsy reports showed an apparent discrepancy in that the kidneys were diseased, when the upper dorsal region was curved, probably a compensatory curve of the lower dorsal or upper lumbar region escaped observation. Histologists state that the nerve filaments entering or leaving a cord segment pass up three segments and down two segments in the cord by their short processes. If this can be accepted all instances of slight discrepancies (placed in column three) would do for placing in column two, and no discrepancies or exceptions need be filed. Abbreviations to save space in the tables which follow: Let C stand for cervical, T for dorsal or thoracic (original text uses the letter D) L for lumbar, S for sacral,- regions, vertebrae, and ganglia of the sympathetic system.

Visceral Disturbances and frequency of occurrence	Vertebral curvatures		Sympathetic connections between vertebrae and diseased organ	Total system check
	Of same sympathetic segment as visceral trouble	Of neighboring segment to visceral trouble		
Thymus Gland Disease (2)	C7 & T1 (1) T 2,3,4 (1)	None (0)	Inferior cervical ganglia	2
Pleural acherent (21)	Upper thoracic (19)	Lower thoracic (2)	Upper and lower thoracic ganglia	19 + 2 21
Lung diseases (26)	Upper thoracic (26)	Lower thoracic (0)	Upper thoracic ganglia	26
Heart and pericardium diseases (20)	Upper five thoracics (18)	C7 and T1 (2)	Upper thoracic ganglia and inferior cervical ganglia	18 + 2 20
Stomach diseases (9)	T 5-9 (8)	(1)	Greater splanchnic nerve	9
Liver diseases (13)	T 5-9 (12)	(1)	Greater splanchnic nerve	12
Cholelithiasis (5)	T 5-9 (5)	(0)	Greater splanchnic nerve	5
Pancreas disease (3)	T 5-9 (3)	(0)	Greater splanchnic nerve	3
Splenic diseases (11)	T 5-9 (10)	T 10, 11, 12 & L1 (1)	Greater, lesser, & least splanchnic n.	10 + 1 11
Inguinal disease (2)	T 12 (2)	(0)	Ilioinguinal n.	2
Kidney disease (17)	T 10, 11, 12 (14)	T 5-9 (1) L 1-2 (2)	Splanchnic n. and upper lumbar ganglia	17
Prostate and bladder disease (8)	L 1, 2, 3 (7)	T 12 (1)	Upper lumbar, lower thoracic, & sacral ganglia	8
Uterus and adnexia (2)	Lumbar lordosis (2)	(0)	Lumbar and sacral ganglia	2
Total visceral disturbances (139)	Curvature at same symp. seg. as disease site (128)	Curvature at adjacent segment (10)	Vertebral curve not related (1)	Total 139

involving the sympathetic synapses in the lateral horns of the cord," 3 then sympathetic disturbances are just as likely to cause functional or organic disease in viscera, by altering the blood supply of viscera, through vaso-motor spasm. Herpes zoster is another example of peripheral disease, caused by nervous disturbance near the exit of nerves from the intervertebral foramen. 4 Beri Beri and angioneurotic edema are other recognized vaso-motor disturbances. Radicular disturbances can be due to rheumatoid arthritis of the vertebrae pressing on the nerves of the brachial plexus. 5

The origin of the sympathetic nervous system is in much closer relation to the habitual site of spondylitis deformans, and much more likely to be pressed upon or irritated by the toxins emanating therefrom than is the brachial plexus. 6 In another series of 25 bodies especially studied by the writer as to minor curvatures, spondylitis deformans, irritation of the sympathetic system and disease in organs supplied by the sympathetic nerves as the vertebrae affected, it was found: 1, that nearly every one of the 25 bodies showed rheumatoid arthritis, either of the head of ribs, of the intervertebral discs, or of the bodies of the vertebrae in the curvature; 2, that rheumatoid arthritis was comparatively rare except in and around the vertebrae in curve; 3, that it was not uncommon in the joints in the extremities; 4, that disease was nearly always found in the organs supplied by that part of the sympathetic system which had its origin at the site of curvatures where there was rheumatoid arthritis; 5, that it was not rare to find an organ diseased which was not supplied by the by the same sympathetic nerves as the vertebrae in curvature with rheumatoid arthritis thereon; 6, that the inflammatory exudate of rheumatoid arthritis of the ribs, discs, and vertebral bodies forming parts of abnormal curvatures pressed directly on that part of the sympathetic system which supplied the viscera found to be diseased; 7, that instead of passing to the diseased organs in a straight line, the sympathetic nerves were stretched over this exudate which angulated the nerves; 8, that even where no bony exudate was found, there was intense rigidity of the segments, showing that fibrous or callous exudate could irritate the sympathetic. Rheumatoid arthritis is now believed to be of toxic or infectious origin. 7 We might assume a toxic or infectious perisympatheticitis to be present, on account of the close association between the sympathetic nerves and spondylitis deformans. In those grosser curvatures where bony callous exudate has not been observed, fatty and fibrous change has been found in the muscles. 8 The blood vessels and lymphatics supplying the cord may be pressed upon by these exudates, or by muscle spasm involved in statistics 9 (trying to correct the deformity and preserving equilibrium). The organs were in many instances affected by acute disease, while the deformed vertebrae proved that the curvatures preceded the organic diseases, though theoretically, reflexes through muscle spasm may reverse the order of procedure.

As all stages between minor curvatures of the spine and advanced spondylitis deformans with ankylosis of the vertebrae have been repeatedly demonstrated on these 25 cadavers, they may be regarded as stages of the same process; the last stage being fixation of segments, immobilization of painful joints being one of nature's later efforts to check the disease. Just so in other joints, the anatomical or mechanical reason for partial or complete ankylosis, is to rest the joint, in the same manner as the callous tends to immobilize the fracture. 10 There are various other chemical, bacteriological, and toxic causes, such as pyorrhea alveolaris, cryptogenic infections, from necrotic teeth, chronic gonorrheal vesiculitis, faulty metabolism etc. 11 The disease going to the point of least resistance, in this instance to the minor curvatures of the spine. That rheumatoid arthritis is secondary to minor curvatures rather than preceding them is more likely, because minor curvatures are frequently in early life, rheumatoid arthritis in later life, also because spondylitis deformans was rarely found except on minor curvatures and because of the beginning of rigidity of the segments from fibrous and collout formation. 12

movement of the sympathetic system can be limited almost exactly to the desired spot. Thus can the sympathetic system be exercised, stimulated by traction, inhibited by flexion.

Twenty-two stray cats were anesthetized, some with gas, some by chloroform, some with ether; the abdomen was opened; the vertebral column hyperextended and direct pressure made from behind with the thumbs against the ninth dorsal vertebra. Result: the abdominal aorta ceased to pulsate. The abdominal aorta was now severed. Result: no blood was extruded. The vertebral column was now flexed. Result: the aorta spurted blood in jets. Flexion and extension were tried repeatedly with the same results. The abdominal aorta was now clamped; the thorax opened; hyperextension of the vertebral column with direct pressure of the thumbs from behind the second, third, and fourth thoracic vertebrae was made. Result: the total excursion (limits of expansion and contraction) of the muscles of the heart was diminished, the auricles weakened and slowed, the effect on the ventricles was less marked. Flexion and removal of pressure from behind permitted the heart to recover, both tried repeatedly with the same result.

Note- the cat has more ribs than man, therefore more thoracic vertebrae. Otherwise the thoracic sympathetic system does not differ greatly from that of man. The head segments are supposed to receive fewer filaments from the inferior cervical ganglia than in man. All cats died painlessly under the anesthetic.

The aorta was not compressed, neither was the heart. In some cats hyperextension of the cervical region, with direct pressure of the thumbs from behind the cervical vertebrae slowed and diminished the excursions of the heart. The Vagal and sympathetic cardiac nerves were severed in others, which permitted the failing heart to increase the dimensions and rapidity of its excursions. In still other cats the phrenic nerves were compressed, through the skin, against the fourth cervical vertebra; this weakened and slowed the conclusion action of the diaphragm. Release of pressure all owed the diaphragm to recover the convulsive action it acquired after the thorax and pleurae had been opened, and before the spine had been compressed. The phrenic nerves were now laid bare, by dissection, and directly compressed against the fourth cervical vertebra, with similar result. Pressure on the phrenic nerves relieves singultus (hiccough) clinically. The experiments on the aorta and heart action were believed to indicate that temporary experimental curves of the spine, when combined with pressure from behind the vertebrae at a suitable level, influenced the blood-supply of the viscera by irritating the vaso-motors, through the sympathetic chain, thus causing the blood vessels to contract. Treatment applied to the human spine clinically would probably have a similar result; so would physical exercises.

Children and dogs wishing to sleep, curl themselves up on their sides, thus bending the vertebral column, relaxing the sympathetic system, filling the great vessels , emptying the cerebral vessels; cerebral anemia is known to cause instant sleep. On awakening, they reverse the process; to stretch the spine and with it the sympathetic system, induces contraction of the great vessels, fills the cerebral vessels; they arise and move around again. "All cats" and many persons "like to have the back stroked," providing it is done the proper way.*

While practically all the observations in this manuscript are the results of the writers personal observations, on skeletons, cadavers etc., he makes no claims for priority, similar observations having been made by others in the Bibliography which follows. Insufficient notice was taken of rheumatoid arthritis in the first 50 bodies. It occurred in nearly all of the last 27. Rib approximations received but little attention as they were nearly always secondary to or associated with minor curvatures of the spine of the vertebra to which the ribs were attached. No doubt more could be made of the sympathetico-vagal communications than appears in this manuscript, unfortunately , the anatomy of the connections between the sympathetic and the Vagus is too little understood to be available in this study. They could explain much, no doubt.

Numerous photographs were submitted illustrating, the similarity of "Vertebral Displacements," "Subluxations," "Lesions," and Minor Curvatures of the Vertebral Column, including deformed vertebrae composing such minor deformations of the vertebral column, but were omitted because they mostly belonged to other writers.

Notes:

1. Both lateral curvatures of the spine and round shoulders, page 94 states: "Bachman in 197 autopsies in scoliotic patients of moderate and severe types has found in 28.3% tuberculosis disease of lungs while in milder degrees of neolisis there were 66% so affected.
2. Fussel's Edition of Tyson, page 1128.
3. Jelliffe and White, Diseases of the Nervous System, page 102.
4. Jelliffe and White page 395, Baerensprung, Marburg and Spiller mention the changes in the posterior ganglia in herpes zoster.
5. Jelliffe and White page 413. "Tuberculosis, syphillitic, carcinomatous, sarcomatous, arthritic infiltrations, about the vertebral canal impinging upon the cords of the plexus can give rise to palsies." "In the course of a rheumatoid arthritis one not infrequently encounters these radicular disturbances which are undoubtedly referable to a vertebral arthritis." A picture of a cervical rib, without mention of a minor curve of the spine, causing brachial palsy, on the same page.
6. Cabot, Physical Diagnosis, says, "A favorite site of the disease (speaking of rheumatoid arthritis) is the lateral expansions of the anterior common ligament (of the vertebral column) or words to that effect. This is the exact site of the sympathetic system.
7. Fussel's edition of Tyson page 75 (or 751 possibly).
8. Lateral Curvature of the Spine and Round Shoulders. Lovette Robert W., M.D. Third Edition, page 89.
9. Dr. J. Madison Taylor on "Statistics" in numerous pamphlets.
10. Hilton, "Rest and Pain" and others.
11. Pemberton, Ralph, M.D., "Studies in arthritis in the army." "The nature of arthritis and rheumatoid conditions." and others.
12. Lateral Curvature of the Spine and Round Shoulders, Lovette, page 126.
13. Lovette, Lateral Curvature of the Spine and Round Shoulders.
14. Fussel's edition of Tyson's Practice of Medicine, page 535. See also Ashhurst, Surgery Principles and Practice, page 20.
15. Duhring said that all disease was nervous or infectious in origin.
16. Sajous, Charles E. DeM. M.D. "The Ductless Glands and the Principles of Medicine" Fourth edition .

Bibliography

Anatomies:- Piersol lecture 1900 & Book. Gray, Cunningham, Morris, Leidy, Gerrish, Deaver, Quain, Hewson, Potter, Young, Testut, Hirschfelt, Toldt, Zuckerkandl, Heitzman, studied.
Physiologies:- Reichert, lecture 1898, Howell, Chapman, Brubaker, Foster, Waller, Mills; in a general way follow the anatomies and state that the sympathetic controls the blood supply of organs through the vaso-motor and blood vessels.
Lovette, Lateral Curvatures of the Spine and Round Shoulders.
Lovette, Orthopedics and Spinal Curvature. The writer has read these books carefully and followed them in detail in his studies of minor curvatures of the spine; which differ from gross curvatures only in degree and in closer association with visceral disease than is evident in gross curvatures.
Abrams Spondylotherapy was of great assistance, e.g. on page 377 and on page 14 of Progressive Spondylotherapy will be found charts closely corresponding to the tables in this manuscript.
Charts by Charles F. Ireland, Columbus, Ohio for electrical treatment applied to the spine for influencing the condition of organs by way of the sympathetic system are almost identical with the tables here presented. Allowance must be made however for the fact that these two authors worked from the spinous processes of the vertebrae, while the author the present writer worked from the fronts of the bodies of the vertebrae.
Jeluffes and White, Diseases of the Nervous System third edition, 1919.
Sajous, Charles E., DeM., M.D. The Ductless Glands and the Principles of Medicine, Edition Four, Philadelphia.
Edgar F. Cyriax, M.D. "Minor Displacements of Cervical Vertebrae," in the Journal de Chirurgie, 191 pg 457-485, reprint by John Bale Sons and Danielson, Ltd 83-91 Great Titchfield St. Oxford St. W1 London England.
J. Madison Taylor, M.D., Manuscripts and Pamphlets on the Clinical aspects of this subject. His corrections and communications have been a wonderful encouragement and help.
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Cabot, Physical Diagnosis.
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Ashhurst, A.P.C., Surgery, Principles and Practice, 1914, Sainz.
Debove, Manual de Pathologica Interna, 1903 Version Espanol Dr. Ron Santiago and numerous others.
Osteopathic literature was freely consulted, including Louisa Burns D.O. "Studies in the Osteopathic Sciences," also Halladay, "Applied Anatomy of the Spine," and books by Hazzard, Hulett, Clarke, Tasker, and others on Osteopathy, with apologies that the lack of space permits no further recognitions.-- the same may be said of The Science of Chiropractic, by B.J. Palmer - on Palmer School of Chiropractic, publisher Davenport, Iowa, USA.

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