The Ram of Reason Seal: Musings on its Origin and Meaning

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The American Academy of Osteopathy (AAO) has long used a Ram's head as its official seal. Members of the AAO are familiar with this icon, seen prominently on the AAO Web site, and on Academy publications such as the AAO Yearbooks, program brochures and letterhead. It is also featured on the medallion proudly worn by Fellows of the AAO.

But what do we know about the AAO Ram's head seal? Why was it chosen? What does it mean? How long has it been in existence? As the reader will soon see, some of these questions are difficult to answer, as the information remains obscure. But a little digging does produce some facts and insight, and sheds some light on the subject.

The ram figure is no stranger to most cultures. The astrological sign Aries is the most familiar connection to the symbol of the ram. Aries is the first of the twelve Zodiac signs and represents rebirth and renewal, signaling the start of the vernal equinox. This association is not unique to astrology; the ram figures prominently in a diverse range of mythologies, including Pharoanic Egypt, pre-Christian Europe, Classical Greece, West Africa, and the Judeo-Christian tradition, and it is often associated with celebrations of the "solar return" or return of spring and fertility after the hiatus of winter.[1] In various contexts, the ram has been seen as a symbol representing such qualities and characteristics as sacrifice, breakthrough, achievement, virility, creativity, the sun and solar power.[2]

For the AAO, the use of the ram's head seal originates with Dr. Andrew Taylor Still himself. In his autobiography,[3] Dr. Still devotes almost the entire text of Chapter 31 to the recounting of a dream in which he had an encounter with a ram. This encounter proved to be a life-changing event for him.

Given that this event is described in Chapter 31 of a 33-chapter autobiography, it would seem that Dr. Still is looking back on his life. In his "first life," as he calls it, he describes several business ventures that proved financially disastrous for him. He had reached a point in his life where he had not only lost money, but had also lost confidence in himself. He was physically and mentally exhausted, and he sat down under a tree to sleep. As he slept, he dreamt that an old ram jolted him on the side of the head, and was about to jolt him again (Figure 1). To escape, Dr. Still climbed up the tree, whereupon he found a label that circled the trunk of the tree. The label read, "This is the tree of Knowledge, in whose shade all persons have received that instruction that was necessary to each individual's success in life, without which no man has ever succeeded."[3] Looking around, he saw there were many labels on the tree, arranged alphabetically. After some searching, he chose a label marked "success," which gave him the information he needed to succeed beyond all his previous expectations.

Figure 1: *Dr. Still about to be jolted by the Ram of Reason.*

Figure 2: *The Ram of Reason, as shown on page 433 of* Autobiography of A. T. Still*, 1897.*

Thus, it would seem that Dr. Still's encounter with the ram in his dream would logically lead to the choice of the ram's head as a seal for the AAO. Oddly enough, although we commonly refer to it as the "Ram of Reason," Dr. Still does not use this term in the text of his chapter. The only place where the phrase occurs is as a caption for a ram's head figure that appears on page 433 of the autobiography (Figure 2).

The actual timeline for the adoption and use of the ram's head seal is not clear. The seal commonly appeared on the covers of the annual AAO Yearbooks, with the earliest appearance on the 1954 Yearbook.[4] Thus, the seal was obviously adopted sometime between 1938 (the year the AAO was founded) and 1954.

[*As an interesting side note, the 1954 AAO Yearbook is listed as the "tenth anniversary issue." Could the seal have been designed and adopted around this time so that its use on the cover of the Yearbook from this time forward would coincide with the publication of the tenth anniversary issue of the Yearbook? In addition, the 1954 Yearbook marks the inaugural appearance of The Yearbook Index, arranged first by subject and then by author. Regular index issues of the Yearbook have been published since that time.*]

John P. Goodridge, DO, reports the following information regarding the AAO seal: "The Ram on the Academy's seal was designed by Reginald Platt, Jr., DO. He designed it 'long before he was introduced to the cranial concept. He apparently picked it up from Still's writings. The idea of the ram's horns coiling and uncoiling like the ram's on the seal. When he saw the crooked horn on the ram in the photograph, he remarked on how it fit the cranial concept.' When his son Reginald Platt, III, DO, remarked 'that it didn't look quite right from an artistic point, [his father] decided to stay with it because it fit the cranial concept so well.'"[5]

The reference to the "ram's horns coiling and uncoiling" and the cranial concept may seem cryptic, but is easily explained. In describing the embryological development of the brain relative to the Primary Respiratory Mechanism (PRM), Harold I. Magoun, DO,[6] notes the following: "Proliferation of the [cerebral] cortex occurs in all directions, giving a bean shape to the hemispheres. Anterior growth is limited by the frontal bone, hence the hemispheres curl like a ram's horn in their development, moving superiorly (frontal lobe), posteriorly (parietal lobe), inferiorly (occipital lobe and anterolaterally (temporal lobe)." (Figure 3).

Dr. Platt, Jr. wished to incorporate this "message" into the AAO seal. Thus, the original ram's head seal depicted one ram horn as curled and the other as uncurled, signifying the curling and uncurling of the brain during motion of the PRM (Figure 4). At a later time, probably in the mid-to-late 1980s, the seal was modernized to its present form (Figure 5).

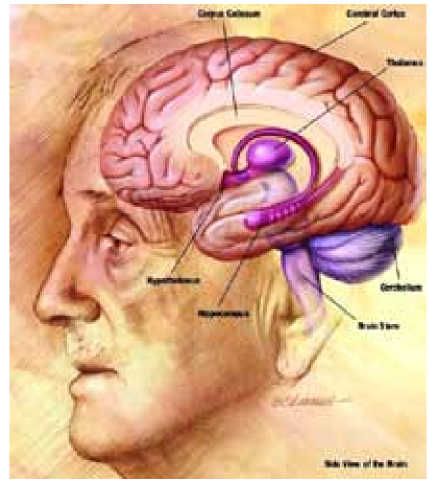

Figure 3: *The ram's horn development of the cerebral cortex.*

Figure 4: *Original depiction of the AAO ram's head seal.*

Figure 5: *Current depiction of the AAO ram's head seal.*

There is much more that could be known about the timeline for the origin and development of the AAO ram's head seal. Perhaps further research into the AAO archives can help. Perhaps there are members of the AAO who could shed more light on this subject. We would welcome such input to complete the story of the American Academy of Osteopathy's ram's head seal.

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What's in a Name? A Brief Look at the History of Board Certification in Neuromusculoskeletal Medicine and Osteopathic Manipulative Medicine

Raymond J. Hruby, DO, MS, FAAO

Introduction

The opportunity to become certified in what is now known as Neuromusculoskeletal Medicine and Osteopathic Manipulative Medicine (NMM/OMM) has been available to members of the osteopathic profession in the United States since 1977. But how did this process come about in the first place, and why? How has it grown and developed over the years to its present status? This article is an attempt to chronicle the history and development of certification in NMM/OMM, in hopes that it will bring some clarity to a process that has been, and sometimes still is, misunderstood and misinterpreted.

Formation of the American Academy of Osteopathy

During the late 1920s and early 1930s, there was a growing perception among groups of osteopathic physicians that there was a serious decline in the use of osteopathic manipulative treatment (OMT). Out of an interest in stimulating a renaissance in the development, research and use of OMT, sectional groups interested in OMT met during the American Osteopathic Association (AOA) conventions. A section devoted to the study and treatment of foot problems, and another interested in treatment of the sacroiliac region, were two of the most prominent groups. They were not approved by the AOA at that time, but always secured a room away from the convention program where they could meet. These sections were well attended.[1] There was also another organized group during that time that called itself the Society of Sacroiliac Technicians.

The American Academy of Osteopathy (AAO) began in 1937 as the Osteopathic Manipulative Therapeutic and Clinical Research Association. It was during that year that Thomas L. Northup, DO, wrote to 135 members of the AOA, inviting them to a breakfast meeting on July 6, 1937. Sixty-three attended the meeting, which preceded the AOA convention. Dr. Northup presided and stated that "his purpose was to initiate the combining of clinical experience and practice into some written form . . . and (emphasized) the need for a section or an organization of the American Osteopathic Association, not just a technic or technical section. (He stated the) purpose would be to develop, investigate, and perpetuate the considerations of osteopathic philosophy and practice, which needed to be preserved. His original support for this idea came from members of the Society of Sacroiliac Technicians."[1]

The group petitioned the AOA for affiliation of its newly-formed association, known as The Osteopathic Manipulative Therapeutic and Clinical Research Association, with the AOA. Its purposes were:

1. Banding together those who are primarily interested in manipulative therapy.

2. Exchange of experiences and ideas relative to manipulative therapy.

3. Collecting and studying clinical reports of cases treated primarily by manipulative therapy.

4. Disseminating among its members the results of its discussions and research investigations as it applies to manipulative therapy.

5. Recording for publication and further study the experiences of men who have been long in practice and have relied for their results principally on manipulative therapy

The petition stipulated that only AOA members would be accepted as members of this new organization, and its section would be a pre-convention meeting and "only registered convention visitors" would be admitted. The petition was signed by 62 AOA members.[2]

In the next few days, the AOA granted a "one year provisional approval of the section of manipulative therapeutics." The newly-affiliated association selected a committee to put on the program for the 1938 AOA Convention in Cincinnati, and a committee to draft objectives and aims for the association.[3] At the 1938 Cincinnati section meeting, the "sponsoring and supporting" group, the Osteopathic Manipulative Therapeutic and Clinical Research Association, adopted its General Objects and Purposes.[4]

Meetings of this organization continued on an annual basis. In 1942, the Society of Sacroiliac Technicians dissolved for its members to join the Osteopathic Manipulative Therapeutics and Clinical Research Association. In 1943, the name was changed to the Academy of Applied Osteopathy, and in 1970, the name was changed to the organization's current name, the American Academy of Osteopathy.

Development of a Certification Process

The AAO continued to flourish. However, as time went on, there was a perceived need to find a way to recognize those DOs who had achieved the highest levels of expertise in the field of OMT. A meeting was held in 1958 to study and establish the Fellowship program of the American Academy of Osteopathy (FAAO). The program was to recognize DOs with special proficiency in manipulative skills, and to encourage others to improve their skills. In the 1959 AAO Directory, the report by President Allan Eggleston contained the following paragraph:

> A proposal was presented to the Board of Governors of the Academy, and to a special committee of the Advisory Board for Osteopathic Specialists, for the formation of a new certifying board called the 'American Osteopathic Board of Manipulative Arts and Sciences.' The proposal was made by a group of osteopathic physicians headed by Dr. T.F. Schooley, Phoenix, Arizona. Proposals for certification in the field of manipulative therapy have been studied for several years with no success in reaching agreement relative to the propriety and value of such a program. Those favoring such a step contend that there must be established a means of recognizing and accrediting the members of the profession who have developed a high degree of knowledge and skill in the field, and whose practices are based principally upon the structural approach. Those opposed to certification in the field contend that the manipulative application of osteopathic principles is basic to every osteopathic physician's approach to the problems presented by his patients, and certification of this basic and fundamental aspect of osteopathy would be improper and would limit the profession. All who have studied the matter are in agreement that a means must be established for recognizing outstanding ability in the field.

In 1960, the committee presented detailed recommendations for the functioning of the American Osteopathic Board on Fellowship of the Academy of Applied Osteopathy (AOBFAAO), which was adopted by the Academy Board of Governors and the American Osteopathic Association's Board of Trustees. The fellowship was described as an "earned" fellowship because it required certain prerequisites, including a 5,000-word written thesis, and oral and written examinations.

The proceedings of the Academy's annual business meeting in Hawaii in November 1971 reported the adoption of a resolution that the President of the American Academy of Osteopathy appoint three members of the Board of Governors, and requested the President of the American Osteopathic Association appoint three members of the Board of Trustees of the AOA to constitute a joint committee to determine the steps necessary to obtain a certification program in osteopathic manipulative medicine. Drs. David Heilig and John Goodridge attended the 1972 AOA Board of Trustees meeting, and spoke to the reference committee to promote raising the FAAO to the level of board certification in the AOA. The resolution was not approved at that time. However, on July 14, 1977, the AOA approved Resolution 60, establishing certification of the FAAO. The Board on Fellowship (FAAO) was now an AOA Board under AOA control.

The AOA asked for a name change of the board in 1983. After surveying the Fellows on their choice of several options, the Academy submitted the name "American Board on Osteopathic Manipulative Medicine," that was approved by the American Osteopathic Association's Board of Trustees in July 1984. Members received AOA membership cards that year stating they were certified in OMM. Somehow, this name change led the American College of General Practitioners in Osteopathic Medicine and Surgery (ACGPOMS), the largest affiliated group in the AOA, to raise concerns. Their concerns were: 1) that designating a certain segment of the profession as being "certified" in osteopathic principles and methods would lead other members of the profession not so designated to feel disenfranchised, and thus fractionate the profession, and 2) that certification of some segment of DOs as specialists (FAAO) would lead to difficulties with reimbursement for the use of OMT by those DOs who were not certified. For reasons still unclear, the AOA requested the name of the board be changed back to the original AOBFAAO, and this was agreed upon by the AAO.

In 1988, physicians emphasizing sports medicine in their practices requested certification by the AOA. The AOA Board of Trustees at this time did not want to establish more certifying boards within the profession. Their response to the sports medicine group was that they should organize an earned fellowship program like that of the AAO without AOA certification. When the leadership of the AAO pointed out that the AOBFAAO was indeed a certifying board, and had been treated as such since the passage of Resolution 60 in 1977,[3,4,5] the AOA Board of Trustees put forth the argument that the 1977 AOA Board of Trustees did not intend to establish the AOBFAAO as a certifying board.

On October 28, 1988, a joint AOA/AAO meeting in Chicago was called by the AOA President for the purpose of resolving this issue. However, such a resolution was not forthcoming. "At this meeting, a position of the current [1988] AOA Board of Trustees was made abundantly clear. This current 1988 AOA Board of Trustees believed that the 1977 AOA Board of Trustees did not intend to establish the American Osteopathic Board on Fellowship of the American Academy as a certifying board."[6]

Resolution 76 was generated at the March 1989 AOA Board of Trustees meeting. It would have eliminated AOA certification of the earned FAAO and returned certification to the Academy's control. At the Academy Convocation in Phoenix on March 28, 1989, Resolution 76 was declared not acceptable to the Academy Board of Governors and a letter, dated March 30, 1989, and signed by AAO President Barbara Briner, DO, was sent to AOA President Marcelino Oliva requesting an April 1989 meeting with the President, President-Elect, Immediate Past President, Chair of the Department of Educational Affairs, Chair of the Department of Professional Affairs, and the Executive Director of the AOA "to gain understanding of this action #76" as the Academy's Board of Governors find some aspects of Resolution 76 "remain obscure."

An Ad Hoc Committee of the AAO met in Washington, DC, with the top three AOA officers and the AOA Executive Director in April 1989. No progress was made toward resolving the disagreement between the AAO and the AOA at this meeting, and it seemed clear the AOA Board of Trustees was prepared to vote on Resolution 76 at their July 1989 meeting.

The Ad Hoc Committee of the AAO requested a special meeting of the AAO Board of Governors. This meeting took place in Cincinnati on June 17, 1989. Two motions were passed:

1. "Move adoption of the recommendation of the Ad Hoc Committee to draft a substitute to Resolution 76 to be submitted to the AOA Board of Trustees and a resolution to be submitted to the House of Delegates to reaffirm the action of the AOA Board of Trustees in the 1977 development of the American Osteopathic Board on Fellowship of the American Academy of Osteopathy."[7]

2. "Move the Board of Governors authorize the Ad Hoc Committee to take all legal steps necessary to reaffirm the status of the [AOBFAAO] as a certifying Board of the AOA."[7]

After the special Board of Governors meeting in Cincinnati, the AAO Ad Hoc Committee prepared resolutions to be submitted to the AOA House of Delegates at their meeting in July 1989. Representing the AAO at this meeting were Drs. Richard Darby, Barbara Briner, and Raymond J. Hruby, who were the Immediate Past President, President, and President-Elect of the AAO, respectively.

In July 1989, when asked at the Nashville meeting of the AOA Board and House of Delegates by the AOA President and later the AOA Executive Director if there was any room for negotiating, Dr. Briner answered "No. We'll take it to a vote."[8] However, after further negotiation by Drs. Briner and Hruby with the AOA President and Executive Director, an agreement was reached whereby the AAO would withdraw its resolutions to the House and Board, and the AOA Board of Trustees would initiate a resolution to reconsider Resolution 76. The vote on this matter was successful.

The AOA then appointed a joint AOA/AAO committee to continue discussions, and a meeting occurred on September 30, 1989, in Chicago. Representing the AAO, Drs. Briner, Hruby and Darby, along with AAO Executive Director Richard Dyson, met with Drs. William Voss, Gil Bucholz, Mary Burnett and Donald Krpan, along with AOA Executive Director John Perrin. Based on meetings, correspondence and discussions up to this point, the following topics were to be discussed:

1. The continued existence of the AOBFAAO as a full certifying board of the AOA.

2. Restructuring of the OMM residency process.

3. Concerns regarding the potential for difficulties in reimbursement for OMT of DOs not deemed certified in OMM.

4. Concerns regarding potential fractionating of the profession if a certain segment of DOs were deemed certified in OMM.

During this meeting, the AOA representatives presented two overarching concerns on their behalf:

1. The process of earning Fellowship in the AAO should be separated from the process of becoming certified in OMM. The AOA representatives pointed out that all other specialty colleges within the osteopathic profession had a certifying board that reported directly to the AOA Board of Trustees, and that the AOA's main concern was to have oversight

over certification within the profession. Fellowship in a specialty college, whether earned or honorary, was a process left to officers of the specialty college itself, and was awarded only after certification in that specialty by the AOA Board of Trustees.

2. OMM residencies needed to be upgraded to meet standards similar to other AOA specialties. At that time, OMM residency consisted of one year of specialized training in OMM following successful completion of an AOA-approved internship. All other AOA-accredited residency programs consisted of at least two years of post-internship training. The AOA wished to see that OMM residents had at least two years of OPP-oriented post-internship training, and further, that this training included OPP aspects of areas including medicine, surgery, pediatrics and other such disciplines, to ensure that certified OMM specialists maintained a high degree of general medical knowledge and skill, as well as OPP expertise. At the same time, they also desired (as did the AAO representatives) to maintain a pathway for DOs trained in other specialties to achieve certification in OMM.

After a long but congenial meeting, all of the above issues were resolved with the following proposals:

1. The AOBFAAO would be terminated and replaced with a new board, which would be known as the American Osteopathic Board of Special Proficiency in Osteopathic Manipulative Medicine (AOB SPOMM). This new board would continue, as did the AOBFAAO, to be a full certifying board of the AOA and report directly to the AOA Board of Trustees.

2. Fellowship in the AAO could still be offered by way of having the AAO appoint a Committee on Fellowship, which would function within the AAO itself, similar to other AOA specialty colleges offering fellowship.

3. The name "American Osteopathic Board of Special Proficiency in Osteopathic Manipulative Medicine" was felt to be one that would not confuse the issue of reimbursement for OMT for DOs, whether certified or not, and would be far less likely to produce feelings of fractionation or disenfranchisement among members of the profession.

4. A plan (see Appendix A) was agreed upon that would establish a) a two-year, post-internship residency in OMM, leading directly to eligibility for certification by the AOBSPOMM; b) a one-year residency in OMM for any DO who completed an AOA-approved residency in orthopedics, general practice, internal medicine or pediatrics (this later became known as the "Plus One" program and was available to qualified DOs from any specialty field), which would also allow for eligibility for certification by the AOBSPOMM; and c) a practice track leading to AOBSPOMM certification, available to any DO who had met internship and residency requirements and been in practice for a specified length of time and met other requirements, such as CME hours in OMM/OPP.

Subsequently, these recommendations were approved by the AOA and AAO Boards of Trustees. In March 1990, one of Dr. Hruby's first acts as then-President of the AAO was to initiate the changes outlined above.[9]

The Next Phase

The AOBSPOMM and the Committee on Fellowship of the AAO functioned quite well. In time, however, it became clear that the use of "special proficiency" as part of the name of the certifying board produced difficulties. The term was often misunderstood, both within and outside the osteopathic profession. Specifically, it was often interpreted as being a certificate of added qualification rather than a full certification.

In an attempt to resolve this problem, the AOBSPOMM voted to change the name of the certifying board to the American Osteopathic Board of Osteopathic Manipulative Medicine (AOBOMM). This request was submitted to, and approved by, the AOA's Bureau of Osteopathic Specialists. However, because the AOA Committee on Basic Documents of Affiliated Organizations raised concerns, the AOA Board of Trustees disapproved the recommendation, and appointed a special task force to study the matter and make further recommendations at a later time.[10]

The special task force considered a number of objections, not only to the requested name change, but also to the existence of a certifying board for OMM. Many of the objections were similar to those that were resolved at the September 30, 1989, meeting, and many of these objections were again raised on behalf of the ACGPOMS. Another issue included this time, though, was a proposal by the AAO to allow allopathic physicians (MDs) to complete AOA-approved residencies in OMM, and receive a credential (not a certification) indicating special proficiency in OMM. Resolution of this topic, however, was considered to be dependent on any final resolution regarding OMM certification, and so did not receive nearly as much attention by the special task force.

After several meetings and much discussion, it seemed that the situation could, in the last analysis, be resolved by adopting a different name for the OMM certifying board than that proposed by the AAO (i.e., American Osteopathic Board of Osteopathic Manipulative Medicine). It appeared all concerns and objections could be alleviated by having the certifying board **not** use the words “osteopathic manipulative medicine” in its name. The American College of Osteopathic Family Physicians (ACOFP) [*Note: The ACGPOMS changed its name to the American College of Osteopathic Family Physicians in 1993*] seemed particularly comfortable with this solution. Summarizing the situation in a memo to the AAO Executive Director dated May 13, 1998, Boyd Buser, DO, made the following comment:

“…I would suggest consideration of a change of the name of our certifying board to the American Osteopathic Board of Musculoskeletal Medicine or some similar designation that does not use the phrase ‘osteopathic treatment’ or ‘osteopathic manipulative medicine.’ This may better describe our practice focus and also remove some of the emotional objection of the ACOFP. If this will allow us to maintain jurisdiction for general certification and preservation of our residency programs, it would seem a small price to pay.”

The reader is referred to Appendix B, the May 7, 1998, AAO white paper on certification in OMM and training of MDs in OMM, for more complete description of the issues facing the special task force.

In May 1998, a by-mail vote of the members of the AOBSPOMM approved changing the name of the certifying board to the American Osteopathic Board of Neuromusculoskeletal Medicine. After approval by the AAO Board of Trustees and Board of Governors, and eventual approval by the AOA Board of Trustees, the final name of the board was the American Osteopathic Board of Neuromusculoskeletal Medicine and Osteopathic Manipulative Medicine (AOBNMM/OMM). This is the name under which the board currently continues to operate. Certification granted is in Neuromusculoskeletal Medicine and Osteopathic Manipulative Medicine (NMM/OMM).

The road to certification in OMM has been a long and convoluted one. Nevertheless, the AOBNMM/OMM is thriving, and has become a recognized influential force in the promotion of the integration of osteopathic principles and practice into all aspects of the osteopathic profession.

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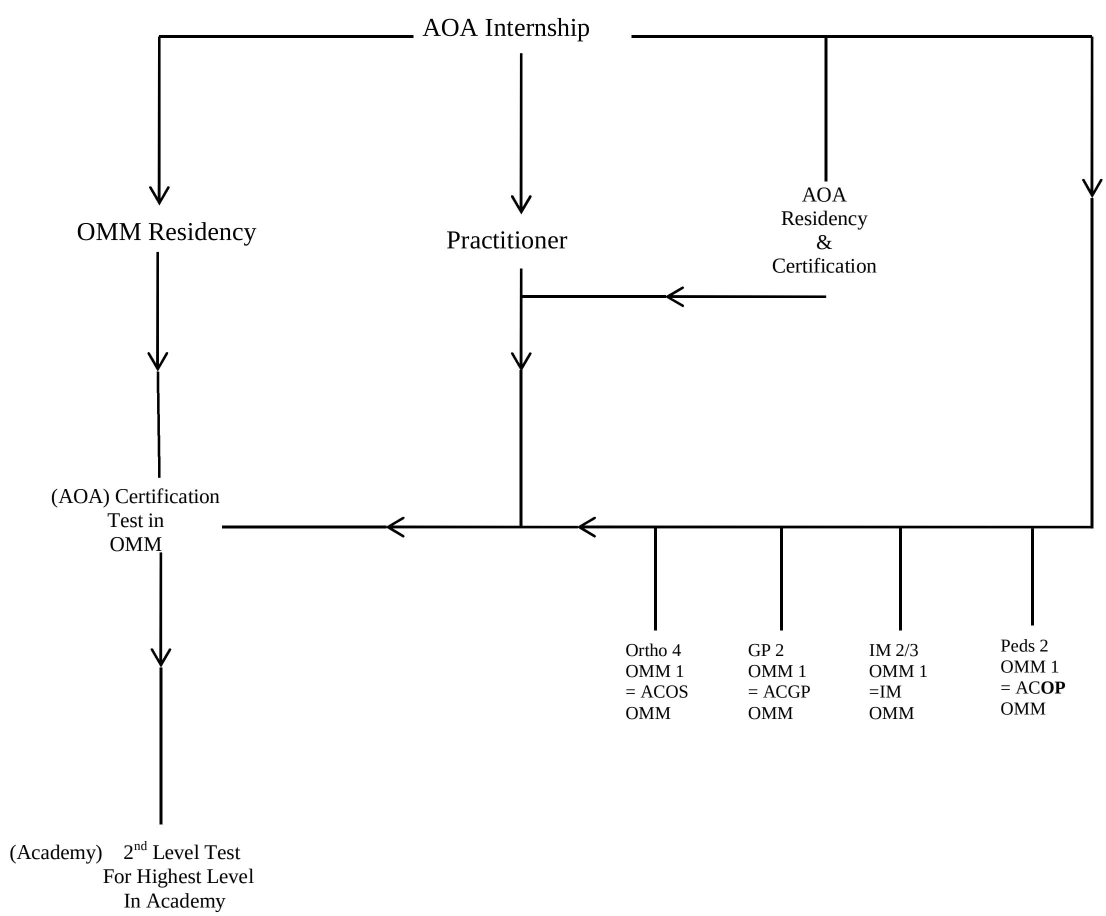
Appendix A

Proposed Pathways to OMM Certification September 30, 1989



Appendix B

"White Paper"

The American Academy of Osteopathy

The American Academy of Osteopathy is one of 22 practice affiliates of the American Osteopathic Association in Chicago, the parent organization of the osteopathic profession. All osteopathic physicians (DOs) are educated in the basic principles of osteopathy, and are trained in the use of osteopathic manipulative treatment (OMT) as part of the curriculum in colleges of osteopathic medicine and postdoctoral training in AOA-approved institutions. The most recent demographic data illustrate that over 50 percent of AAO members are osteopathic family physicians, with the remainder integrating OMM in a variety of osteopathic medical specialties, the majority of those being specialists in osteopathic manipulative medicine (OMM).

The Mission of the American Academy of Osteopathy is to teach, explore, advocate and advance the science and art of total health care management, emphasizing osteopathic principles, palpatory diagnosis and osteopathic manipulative treatment.

Certification

The Academy fully recognizes and supports certification granted by all of the AOA's 18 certifying boards. However, the Academy has special interest in the American Osteopathic Board of Special Proficiency in Osteopathic Manipulative Medicine (AOBSPOMM), and annually nominates candidates to serve on this certifying board for appointment by the AOA President.

AOBSPOMM was established in 1990 by the AOA Board of Trustees and granted the jurisdiction for general certification in "special proficiency osteopathic manipulative medicine." Currently, the Board provides two pathways for certification in OMM—either through completion of a two-year residency in OMM or via a five-year practice requirement accompanied by 250 hours of continuing medical education (CME). The AOBSPOMM has examined and recommended for certification a total of 195 osteopathic physicians since 1990.

The years of postdoctoral training (internship/residency) and private practice influence the manner in which each individual expresses his/her practice of osteopathic medicine. In order to recognize extraordinary proficiency in osteopathic manipulative medicine, the AOA created the AOBSPOMM. This certifying board conducts an application and examination process, which enables the individual DO to demonstrate his/her special proficiency in an area of practice. This certification of special proficiency in osteopathic manipulative medicine is conferred by the AOA.

AOBSPOMM Name Change

In the fall of 1997, the AOBSPOMM voted to change the name of the certifying board to the American Osteopathic Board of Manipulative Medicine (AOBMM) and submitted the change to the AOA's Bureau of Osteopathic Specialists. However, the AOA Board of Trustees disapproved the Bureau's recommendation at its February 1998 meeting with this explanatory statement: "The name change is not well understood by this Committee (on Basic Documents of Affiliated Organizations) and we need additional information, review and discussion before taking positive action on this request." Subsequent to the Board's February meeting, AOA President Howard Levine appointed a special task force to study the matter and make a recommendation to the Board at the July 1998 meeting.

Academy's Position

The Academy's Board of Trustees endorses the recommended name change to AOBMM. The rationale for this support includes, but is not limited to, the following points:

1. the inclusion of "special proficiency" in the name of the certifying board and individual physician's certificate has been widely misunderstood, both within and outside of the osteopathic profession, by some even being interpreted as a certificate of added qualification rather than the earned general certification. This is critical for those DOs who hold only general certification in OMM, especially complicated by the fact that there is no corresponding certification available in the allopathic community;

2. OMM-certified clinical faculty in the departments of osteopathic manipulative medicine in the nation's colleges of osteopathic medicine (COMs) should have their earned credentials recognized on the same level as their fellow faculty members, i.e., certified in OMM. Accreditation standards for COMs stipulate that "The department/divisional chair must have proven experience in teaching and academic leadership in a medical education setting. In the primary care disciplines, faculty must be *AOA Board-certified osteopathic physicians."* (emphasis added);

3. OMM-certified staff clinicians in departments of osteopathic manipulative medicine in the nation's AOA-accredited health care institutions should have their earned credentials recognized on the same level as their fellow DO medical staff members, i.e., certified in OMM. This is parallel to DOs who are certified in internal medicine, but also in cardiology, gastroenterology, etc. Further parallel are those DOs certified in general surgery, but also in thoracic surgery, urological surgery, etc.;

4. OMM-certified DOs who limit their practice to the federally recognized specialty of osteopathic manipulative medicine deserve to have their earned credential unequivocally recognized as general certification within their own profession;

5. Standards for the accreditation of Osteopathic Postdoctoral Training Institutions (OPTI) dictate that there be a provision "for the integration of osteopathic principles and practices (OPP) throughout all AOA postdoctoral programs approved within the OPTI in accordance with specialty college basic standards requirements." Leaders within the osteopathic profession are discussing the addition of a requirement that every OPTI have an OMM residency training program to ensure the integration of OPP into these postdoctoral programs. OMM-certified DOs are currently providing for this integration and will become increasingly in demand by OPTIs to fulfill this requirement.

Objections from AOA Practice Affiliates

As AOBSPOMM has advanced the name change, there has emerged vocal opposition from a number of individuals and selected AOA practice affiliates. Some opponents have alleged that the change will be divisive within the osteopathic medical profession and have issued informal challenges to the change. However, up to this time, neither the AOBSPOMM nor the Academy have received any written objection to the change, with the exception of the Committee on Basic Documents of Affiliated Organization's explanatory statement to support its recommendation at the February 1998 AOA Board of Trustees meeting. Although the AOBSPOMM and the Academy have previously placed in writing their rationale for the change, the AAO now responds to the informal challenges received to date.

Challenge #1: The deletion of "special proficiency" will limit the delivery of OMT in the hospital and managed care plans to OMM-certified DOs.

AAO Response: During the years of pre-doctoral training, all future osteopathic physicians are taught the philosophy, sciences and art of their profession. A core exposure to, and preparation in, the various models of osteopathic manipulative medicine is central to this educational process. At the time of conferring the DO degree, each new Doctor of Osteopathy has been prepared to undertake the distinctive practice of osteopathic medicine. By virtue of their degree and licensure, all DOs are qualified to utilize OMT in the care of their patients, both inpatient and outpatient.

It is true that some AOA-accredited hospitals have chosen to require OMM certification as a pre-requisite for providing inpatient *specialty-level consultations* in osteopathic manipulative medicine. It is also true that some DOs who limit their practices to OMM have applied for and been granted "specialist" recognition in managed care plans.

However, the Academy strongly opposes the limitation of the appropriate utilization of OMT by any DO, and has assisted many AAO members in appealing the denial of such utilization. The Academy advocates the right of osteopathic family physicians to deliver OMT to their hospitalized patients. The AAO further advocates training for all staff physicians in the use of the osteopathic musculoskeletal examination of the hospitalized patient, and the delivery of OMT in the treatment of the somatic components of the patient's disease/conditon. Finally, the Academy offers assistance to all AOA practice affiliates as they promote increased utilization of osteopathic diagnosis and OMT in the delivery of health care to patients, regardless of the point of service.

Challenge #2: The deletion of "special proficiency" will create a two-tier level of reimbursement for OMT by third-party payors.

AAO Response: By virtue of earning the DO degree, all osteopathic physicians are trained in osteopathic diagnosis and OMT and should be equally reimbursed for these unique services. The Academy opposes all efforts by third-party payors to limit the utilization of, and reimbursement for, OMT by any DO in the treatment of patients.

In the American Medical Association's CPT Manual, there are five codes to categorize the delivery of OMT in patient care: 98925-98929. Academy representatives have served the AOA in a collaborative leadership capacity to advocate for the inclusion of OMT codes in CPT, and for determination and preservation of relative work values for these codes with the federal Health Care Financing Administration. There has never been an occasion when the Academy or its representatives have advocated for anything but a single level of reimbursement for OMT services. Rather, the Academy has worked for all DOs in promoting equitable physician payment policy.

Consider the recent data generated by the Health Care Financing Administration regarding 1996 Medicare program billing for evaluation and management services (E&M) and OMT on the same date of service. The data show that 69 percent of the OMT services in the sample file were delivered by general/family practice physicians, with the remaining 31 percent being delivered by various osteopathic specialty physicians (16 percent by OMM specialists).

Challenge #3: The deletion of "special proficiency" will infer the osteopathic profession's support for peer review of DOs to be conducted only by OMM-certified DOs.

AAO Response: The AOA maintains two positions on peer review. First adopted in 1981, and most recently reaffirmed in 1994, one states that "all peer review under the peer review organization program of osteopathic diagnosis and therapeutics be performed by osteopathic physicians." The other, adopted in 1996, further states that the AOA "supports peer review of osteopathic physicians, where feasible, by other osteopathic physicians who have earned the same AOA certification credentials."

The Academy fully supports both of these AOA positions. However, at the request of its members, the Academy also strongly advocates a position to third-party payors that only OMM-certified DOs should conduct definitive peer review on other DOs who limit their practices to OMM. The Academy believes that this position is consistent with the 1996 AOA policy.

Challenge #4: The deletion of "special proficiency" will diminish the recognition of OMT expertise earned by DOs via the American Osteopathic Board of Family Physicians (AOBFP).

AAO Response: The Academy compliments the AOBFP for inclusion of an OMT component in its certifying examinations, and highly recommends similar action by the other 16 AOA certifying boards. However, the Academy does not believe that the name change will adversely affect the recognition of expertise in OMT delivered by family physicians any more than AOA certification in obstetrics, dermatology, cardiology, etc., diminishes the opportunity for family physicians to deliver babies, surgically remove skin lesions, manage patients' congestive heart failure, etc.

The fact of the matter is that certification in family practice is recognition of "special proficiency" in managing the general health care needs of all patients in the family. Certification in OMM recognizes "special proficiency" in the knowledge and use of osteopathic principles in the diagnosis and management of health problems with special emphasis on the role of the neuromusculoskeletal system in health and disease.

Challenge #5: OMM-certified physicians are specialists and should not be treating the general medical needs of patients.

AAO Response: First of all, OMM-certified physicians are certainly capable of managing the total health care of their patients. As of April 1998, the AOA physician master file data shows that there are 256 OMM-certified osteopathic physicians (of that number, 109 are also certified in family practice and 12 more are also certified in other AOA specialties). Hence, there are 135 DOs who hold only their AOA primary certification in OMM.

DOs who limit their practice to OMM are legitimately practicing a federally-recognized specialty, which is appropriately defined in basic documents approved by the AOA Board of Trustees, e.g., the *Basic Standards for Residency Training in Osteopathic Manipulative Medicine* and the *Glossary of Osteopathic Terminology*.

The Academy is on record in advocating that OMM is a primary care specialty. In fact, in its reports to the federal government, the AOA aggregates OMM-certified physicians with other primary care physicians. OMM, by its very nature, is primary care medicine as defined in the *Basic Standards for Residency Training in Osteopathic Manipulative*

Medicine. The definition, as found in Article II, A, states: "Osteopathic manipulative medicine is that component of medicine concerned with the implementation of that part of the osteopathic philosophy, which emphasizes the interaction of body systems as a principle tenet for understanding the total body as an integrated unit..."

In terms of primary care, this means the practicing OMM physician cares for the entire person, with a special emphasis on the neuromusculoskeletal system. The article further states, "Such knowledge and skill is not confined, therefore, to the care of specially-selected patients, but also includes the neuromusculoskeletal factors important for consideration in the *management of every patient* (emphasis added).

Physicians who limit their practices to OMM typically refer the management of the general health needs of their patients back to the family physician, just as other specialists within the osteopathic profession do.

The Academy advocates the integration of OPP and OMT into all AOA specialty training, and offers assistance to all AOA practice affiliates who wish to deliver CME programs which promote increased utilization of OMT by their members. OMM–certified DOs who are specialists (e.g., internal medicine, orthopedic medicine, OB/GYN, preventive medicine, etc.), by virtue of their degree and additional certification in OMM, should not be limited in their application and utilization of OPP and OMT in their practices.

Graduate Medical Education and Credentialing for Allopathic Physicians (MDs)

For many years, the Academy has noted an increased interest in OMM on the part of allopathic physicians. Hence, the AAO presented a resolution to the AOA House of Delegates in July 1993 which called for the delegates to authorize the Academy to "propose a mechanism whereby allopathic physicians and surgeons may take post-doctoral training in OMM, which leads to appropriate credentialing by the AOA through AOBSPOMM." The House of Delegates approved that resolution.

Subsequently, the Academy developed such a mechanism and presented it to the July 1994 AOA House of Delegates, which referred the matter to the AOA Bureau of Professional Education. From July 1994 through February 1996, the Academy's leadership presented this mechanism and revised the proposal as requested by the Bureau of Professional Education, Council on Postdoctoral Training and Bureau of Osteopathic Specialists. Ultimately, the AOA Board of Trustees approved the mechanism at its February 1996 meeting, resulting in the required revisions in the *Basic Standards for Residency Training in Osteopathic Manipulative Medicine.*

Over a year later, the Bureau of Osteopathic Specialists considered required revisions in the AOBSPOMM Constitution and Bylaws necessary for examination and awarding a "credential" in special proficiency in OMM to MDs who had completed OMM residency training. There was opposition to the AOBSPOMM changes by individual members of the Bureau. Hence, in July 1997, the Bureau recommended that the matter be studied thoroughly by the Academy and the objecting parties before implementation.

The Bureau of Osteopathic Specialists recommended to the AOA Board of Trustees in February 1998 that the AOA President establish a special task force to study the matter and review all AOA policies which may be affected by such revisions. The Board of Trustees approved the resolution. However, the Board also rescinded its February 1996 approval of the mechanism to enroll MDs in OMM residency training.

AAO Position

The Academy supports changes in the AOA's basic documents which would permit enrollment of MDs in OMM residency training and examination of MD graduates of these residencies for a "credential" of special proficiency in OMM. The rationale for the Academy's position is well documented in written public testimony and transcripts of the procedures at various AOA meetings. The Academy has sent a comprehensive, chronological set of documents to the AOA Special Task Force on OMT Certification and Credentials.

The Academy has no hidden agenda on these matters. The AAO leadership took the matter to the 1993 AOA House of Delegates and received approval to proceed. In 1994, the AOA House of Delegates approved the initial proposed mechanism and referred it to the appropriate AOA bodies for review. Everything has been out in the open and modified to accommodate concerns expressed by various AOA bodies.

The neural basis of the osteopathic lesion*† (1947)

Four of the main principles in osteopathy appear to be:

1. Joints and their supports are subject to anatomic and functional derangements.
2. These derangements have distant as well as local effects.
3. They are related, directly or indirectly, to other pathologic influences.
4. They may be recognized, and their local and distant effects influenced favorably by manipulation.

Accepting the existence of joint derangements (osteopathic lesions), it is our purpose in this paper to examine not the mechanical and etiological factors involved, but rather the fundamental basis for principles 2 and 3 and to a small extent principle 4, and to report progress in our understanding thereof.

The osteopathic lesion has many aspects which are partly revealed in the local and distant effects referred to as principle 2. Included among these are:

1. Hyperesthesia, especially of the muscles and vertebrae.
2. Hyperirritability, reflected in altered muscular activity and in altered states of muscular contraction.
3. Changes in tissue texture of muscle, connective tissue, and skin.
4. Changes in local circulation and in the exchange between blood and tissues.
5. Altered visceral and other autonomic functions.

How are these effects produced? What are the central factors responsible for these manifestations of structural and postural abnormalities? What in the intrinsic nature of the osteopathic lesion is the basis for the peripheral, palpable, and clinical effects? What fundamental changes take place as a result of effective manipulative therapy?

*Presented before the Teaching Group on Osteopathic Principles, Diagnosis and Therapeutics at the Fifty-First Annual Convention of the American Osteopathic Association, Chicago, July 21, 1947.

†The research on which this paper is based was made possible by grants from the Research Committee of the American Osteopathic Association.

The detailed answers to these questions are, of course, not yet available, but reliably indicated are the general nature of the final answer and the direction in which we must proceed in order to obtain it. The research program of the Kirksville laboratories is designed to procure some of these answers through exploration of the intimate mechanisms involved in the osteopathic lesion. We believe that the answers are obtainable only through fundamental, experimental research and that the emerging concept of the lesion and its implications will have considerable impact on the practice of osteopathy.

In this paper will be presented some of our current views, some of the practical implications, and some speculations. The details of the experimental methods and the raw data, available in earlier publications,[1,2] will not be presented, but rather the general experimental approach and the immediate conclusions therefrom. From these, in turn, will be drawn some generalizations.

The neural basis of the osteopathic lesion

Within the nervous system, in the phenomena of excitation and inhibition of nerve cells, and in synaptic and myoneural transmission, lie the answers to some of the most important theoretical and practical osteopathic problems. The existence of a neural basis for the lesion has been known, of course, for a long time. The segmental relation of the osteopathic lesion to its somatic and visceral effects is explainable in no other way.

The activity and condition of the tissues and organs are directly influenced, through excitation and inhibition, by the efferent nerves which emerge from the central nervous system and which conduct impulses to these tissues and organs (Fig. 1). For example:

Muscle.

A. Anterior horn cells (Motoneurons) — muscular contraction
B. Lateral horn cells (Sympathetic preganglionic neurons through postganglionic neurons) — vasomotor activity

Skin.

C. Lateral horn cells — vasomotor activity
D. Lateral horn cells — sweat gland secretion
E. Lateral horn cells — piloerection

Viscera.

F. Lateral horn cells — smooth muscle contraction
G. Lateral horn cells — glandular secretion
H. Lateral horn cells — vasomotor activity

The activity of these organs and cells is directly determined by the activity of their motor nerves. This nerve activity is measured in terms of: (a) The number of impulses conducted by each efferent nerve fiber and (b) the number of fibers involved. Thus, in the absence of impulses in the corresponding motor nerve, a muscle is completely at rest. The amount of contraction (tension produced or degree of shortening) at any moment is in proportion to the number of motoneurons which are conducting impulses at that moment and the average number of impulses per second which each is conducting to the muscle. With certain modifications this principle also applies to organs other than muscle. Abnormalities in these organs are produced by overactivity or underactivity of the efferent nerves.

Secondary effects of neural imbalance

It is important to emphasize, however, that not all the effects of overactivity or underactivity of the efferent neurons are direct and immediate. Secondary effects often assume predominate importance. Thus, a muscle's overactivity, over a long period of time, may result in fibrosis and major chemical and metabolic changes; underactivity, in atrophy. Overactivity of sympathetic fibers which control arterioles may result in local anoxemia, inflammation, altered capillary permeability, edema, etc. Imbalance in the efferent neurons controlling the smooth musculature of the gastrointestinal tract may result in flaccidity or spasm with serious effects on digestion and absorption and, therefore, on the entire body economy. Overactivity or underactivity of the neurons controlling glands may result in disastrous shifts in acid-base, fluid, and electrolyte balance and in such conditions as peptic ulcers. If the gland happens to be one of the endocrines, the effects may be especially serious and extensive. We may for the present purpose include the spinothalamic fibers among the "efferent" neurons. These convey pain sensations to the brain and, when overactive, produce not only physical but also important psychological changes with potentially serious and extensive changes in motor and visceral activity. With the crucial importance of the efferent neurons in mind, more precise formulation of the problem is possible. There are three main questions:

1. What factors control the activity, i.e., the number of impulses, in the efferent nerve fibers?

2. How does structural abnormality, i.e., the osteopathic lesion, play upon these factors to produce overactivity or underactivity of these fibers and, therefore, of the organs which they innervate?

3. How does manipulative therapy play upon these factors to restore balance and cause regression of signs and symptoms?

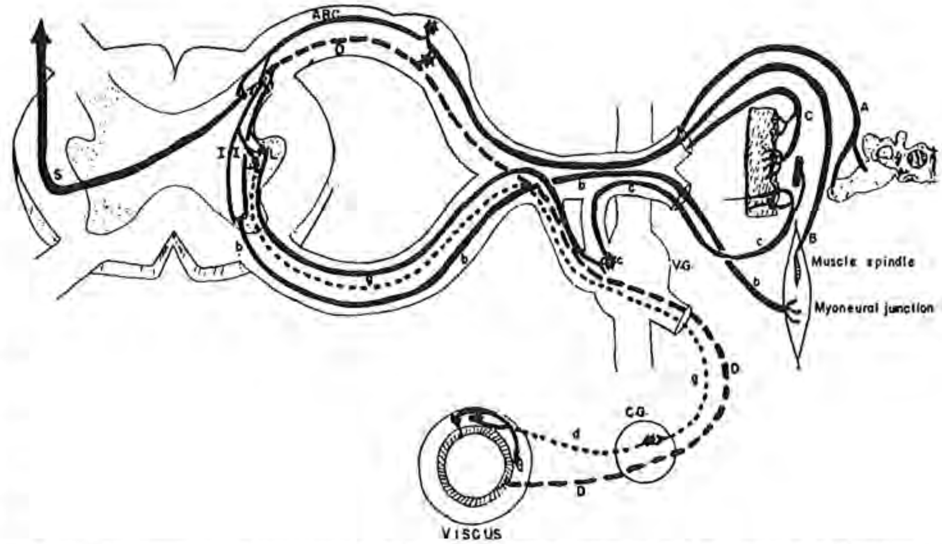


Fig. 1.—Diagrammatic representation of segmental reflex pathways among somatic and visceral afferents and efferents.

Afferents *(Dorsal root neurons):*

A—From spinous process, joints; B—From stretch and tension receptors (proprioceptors) in muscles and tendons; C—From touch, pressure and pain endings in skin; D—From viscera; ABC—Somatic afferents.

Efferents: *b—motoneurons to skeletal muscle; c—sympathetic postganglionic neurons to blood vessels of skin and muscle; to sweat glands and pilomotor muscles of skin; d—sympathetic postganglionic neurons to visceral smooth muscle, blood vessels and glands; S—Spinothalamic fibers; I — Interneurons; L — Lateral horn cells (sympathetic preganglionic neurons); V.G. — Vertebral ganglion; C.G. — Collateral ganglion.*

Factors controlling efferent activity

Let us proceed to the first question. What factors has physiological research demonstrated to be primary in the control of activity of the efferent neurons? Two main principles have special pertinence here.

A. The principle of reciprocity states that through the network of interneurons (also known as internuncial neurons, intercalated neurons, and connector neurons), which is situated within the central nervous system, every neuron potentially influences, and is influenced by, almost every other neuron in the body.[3]

B. The principle of convergence states that many nerve fibers converge upon, and synapse with, each motoneuron. These presynaptic fibers convey impulses from a large variety of sources to the efferent neuron which, therefore, represents a final common path.[4]

Let us examine how these principles operate with respect to the anterior horn cells, keeping in mind that they probably operate in a similar fashion upon the other efferent neurons (Fig. 1).

1. Each anterior horn cell receives impulses from a large number of sources through the presynaptic fibers which converge upon and synapse with it. All the descending tracts in the spinal cord, conveying impulses from such sources as the cerebral cortex, red nucleus, medulla oblongata, the vestibular nuclei, cerebellum, the pons, superior colliculi, and other higher centers, establish synaptic connections with the anterior horn cell for the mediation of voluntary motion, equilibrium, postural reflexes, visuospinal reflexes, and others. The proprioceptors, stretch and tension receptors situated in the tendons and in the muscles themselves, are a steady and continuous source of impulses. They exert their influence directly through the dorsal root fibers into which they discharge their impulses or, indirectly, through the higher postural and equilibrium centers. Afferent fibers from the viscera may also play an important role. In fact, every afferent nerve fiber, whether it mediates touch, pain, pressure, temperature, sight, or any other sense modality, exerts influence upon the final common path represented by the motor nerves.

2. Some of the converging fibers exert an excitatory influence, others an inhibitory influence on the same motoneurons.

3. The activity of the motoneuron at any moment, that is, the frequency with which it delivers impulses to the muscle fibers, represents a dynamic balance among all the excitatory and inhibitory influences being exerted by the many neurons which converge upon it. The proprioceptors and some of the higher centers, through their steady, tonic control, act as governors or buffers. The balance, however, is shifted from moment to moment in accordance with changes in the internal and external environment and in response to volition. As previously stated, pathology results when the balance is shifted too far in one direction or the other (excitation or inhibition) for too long.

4. The collective action of the presynaptic nerve fibers upon the final common path is further reflected in the phenomena known to physiologists as reinforcement and facilitation. Before the anterior horn cell can discharge impulses into the muscle fibers, it must itself receive excitatory impulses simultaneously from a number of presynaptic fibers.[5] Stated

another way: Before a given stimulus (e.g., to the skin) can produce a reflex muscular response, the anterior horn cell must first be "warmed up" or "put on edge" (facilitated) by impulses from other (excitatory) fibers which synapse with it. The efferent neuron must already be in a state of subthreshold or subliminal excitation. In other words, the various fibers converging upon a given group of motoneurons must cooperate (reinforce each other) in order to open the final common path leading to the muscle. In a whole nerve it has been demonstrated that a considerable portion of the nerve fibers must be in a state of subliminal excitation before *any* of them fire and cause muscular contraction.[6]

5. This requirement serves as a margin of safety or an insulation, preventing muscles from responding to every impulse which reaches the anterior horn cell.

6. When a significant percentage of the anterior horn cells in a given segment of the spinal cord is maintained in a state of subliminal excitation, they require little additional stimulus to produce a reflex response. This is reflected in our frequent use of the terms "on edge," "jumpy," "tense," which imply motor aspects of psychic imbalance. In individuals thus characterized the anterior horn cells are maintained close to, or at, threshold, even during rest.

The osteopathic lesion and the factors controlling efferent activity

The second question in our series of three was "What is the relation of the osteopathic lesion to the above factors?" How do anatomic and functional derangements of the joints and their supports operate on these factors to produce seriously altered activity of the efferent neurons? Considerable light is being thrown upon this problem by the research in progress at Kirksville College of Osteopathy and Surgery under the directorship of Dr. J. S. Denslow. The research has revealed close relations between lesion mechanisms and certain well-established physiological principles. The general experimental approaches and the major conclusions from each are presented in the following section.

Experimental

Reflex threshold.

Denslow,[1] proceeding from the observation made by all osteopathic physicians that pressure to the spinous processes of lesioned segments produces much more contraction in the spinal extensor muscles, and with less pressure, than is true at non-lesioned segments, set out to determine in a precise, objective manner how much pressure is required at each spinous process to elicit reflex contraction of the spinal extensor at the same level. In other words, his object was to determine whether, and to what degree, lesioned segments were distinguished from the normal by differences in reflex threshold.

Muscular activity was determined electromyographically, that is, by recording the electrical signs of muscular activity. Measured pressure stimuli were applied to the spinous processes by means of a calibrated pressure meter which simulated the action of the osteopathic thumb. At each segment gradually increasing pressure stimuli were applied to the spinous process until just detectable activity in the erector spinae mass was obtained; this represented the reflex threshold for that segment. The reflex arc under investigation might be said to consist of these parts: spinous process, dorsal root fiber, interneuron, anterior horn cell, and muscle fibers. (See Fig. 2, disregarding segmental designations and intersegmental connections.)

This pioneer study upon a large number of human subjects resulted in the demonstration that the reflex thresholds in lesioned segments were much lower than in normal segments. The more severe the lesion, as determined by palpation, the lower the threshold. The thresholds may be constant over periods of months.

What is the basis for the lowered reflex threshold of the lesioned segment? There were two obvious alternatives. (1) *The sore spines.* It was reasonable to suppose that the pressure receptors and nerve endings in the tender spinous process were hypersensitive and that, per gram of pressure, they fired more impulses at the anterior horn cells than did the corresponding endings in the normal spinous process. (2) *Hyperirritable motoneurons.* It appeared equally reasonable to suppose that for some reason or other the anterior horn cells of the spinal extensor muscle in the lesioned segments were maintained at a higher level of excitability. In order to decide which was the more likely alternative, the following experimental approaches were undertaken.[2]

Intersegmental spread of excitation.

A lead to the answer was given in experiments in which spread of excitation from segment to segment was examined in relation to their respective thresholds, to the distance between them, and to other factors. The experiments were conducted as follows (Fig. 2). The four thoracic segments, designated as T4, T6, T8, and T10, were selected for this series of experiments on 30 subjects. Needle electrodes were inserted into the spinae erector mass 5 cm. to the left of the spinous process in each of the four segments, for the detection and recording of muscular activity. Pressure stimuli were applied to the spinous processes with the pressure meter.

The minimum pressure stimuli (threshold) required at each of the four spinous processes to elicit activity from each of the four muscle segments was then determined in turn. Thus, the pressure required upon the spine at T4 to elicit activity in the muscle at T4, in the muscle at T6, in the muscle at T8 and in the muscle at T10 was determined. This was then repeated at the other spinous processes, giving four thresholds at each spinous process, sixteen in all, in each experiment. The results will be summarized by illustrating with one hypothetical subject, eliminating some qualifications for the sake of brevity.

It was found that there was much more spread *to* lesioned segments than *from* lesioned segments. Thus, if T6 were a severely lesioned segment (very low threshold) while T8 and T10 (neglecting T4 for the moment) were normal or high threshold segments, the following obtained. It required very little pressure to the spinous process of T6 to elicit activity of the muscle in the same segment; but even very strong pressure stimuli to the same spinous process failed to produce any signs of activity in the muscles at T8 or T10. Conversely, although even very high pressures to the spinous processes of the latter two segments produced no activity in either of these segments, relatively slight pressures upon the spinous processes of each of them did stimulate reflex contraction at T6. Thus, excitatory impulses entering the cord at T10 "by-passed" the motoneurons of the same segment and those of a neighboring high-threshold segment, to emerge or produce effect at a more remote lesioned segment.

If T4 were moderately lesioned (as was often the case if there was a leison at T6), it participated in exchange of excitation with T6, but usually only *received* excitation from T8 and T10.

Our conclusion from this series of experiments can be simply stated in an analogy. The anterior horn cell of the lesioned segment represents a bell easily rung from a number of push buttons, while the spinous process or push button of the lesioned segment does not easily ring bells other than its own. The hyperexcitability of the lesioned segment (that is, the relatively low reflex threshold) is demonstrable without applying pressure to the corresponding spinous process.

Procaine studies.
It was of interest in this connection to determine whether and how the excitability of the lesioned segment was affected by desensitization of the spinous process with procaine. Infiltration of the periosteum around the spinous process raised the local threshold to that of a normal segment, that is, it was no longer possible to produce reflex response of the muscle of that segment with slight, moderate, or even heavy pressure stimuli to the spinous process of that segment.

In contrast, however, spread of excitation *to* that segment from other segments remained unimpaired; although pressure to the procainized spinous process of T6 no longer elicited reflex contraction at T6, it was still possible to elicit contraction at T6 by pressure upon spines T8 and T10. Thus, the hyperexcitability of the lesioned segment was again demonstrated independently of the spinous

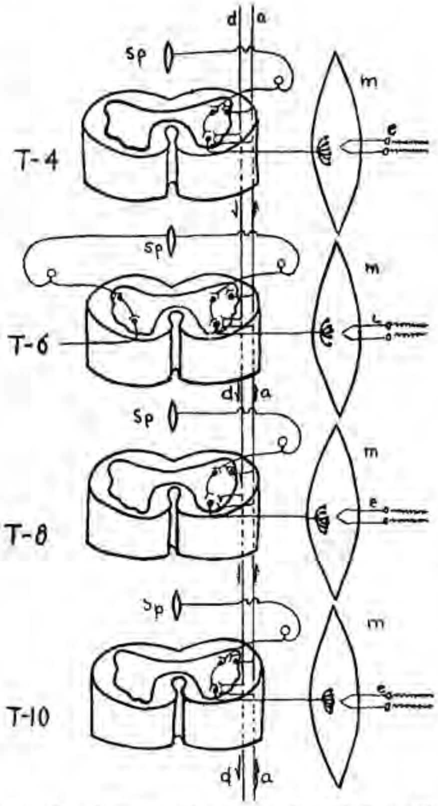


Fig. 2 — Diagram of reflex pathways involved in experimental measurement of segmental reflex thresholds and of intersegmental spread of excitation. (See text.)
sp — sensory endings in spinous process; a, d — ascending and descending intersegmental neurons; m — erector spinae mass; e — recording electrodes.

process; it exists even when the spinous process is desensitized.

Bilateral differences.
On a few subjects the reflex responses on both sides of the same segment were simultaneously observed (Fig. 2, T6). It was found that the spinal extensors on one side of the segment may respond reflexly to very slight pressure upon the spinous process while the other side requires much higher pressure to the same spinous process. In other words, low or high thresholds are not determined by the spinous process. The neurons in the left and right horns of the same segment may be maintained in different degrees of excitability. The left and right "bells" are rung with different degrees of facility from the same "push button."

Rest activity.
The differential excitability of anterior horns in lesioned and nonlesioned segments was further and clearly shown in experiments in which the anterior horn cells were exposed, not to impulses from spinous processes but to generalized stimuli coming from within and without the body.

When a patient is prone and completely relaxed there is usually no activity in the spinal muscles; there is not even tone, as indicated by the absence of action potentials in those muscles. This is true, usually, even of segments in lesion.

Occasionally, however, it was found that muscular activity persisted in the absence of external stimulation. The subjects had to be carefully positioned and repositioned to eliminate as far as possible the afferent bombardment from the proprioceptors. It was found that when rest activity did occur, it was almost invariably in the lesioned, low threshold segments. Thus, the segment in lesion is the most sensitive to positional stress, conveyed by the proprioceptors in the muscles and tendons.

Mental factors may also be responsible for rest activity. Subjects who are apprehensive, anxious, or emotionally upset often show persistent rest activity. Such activity was always most marked in the lesioned segment; often it occurred *only* in the lesioned segments. The lesioned segment is thus hyper-responsive to impulses descending from the cerebrum.

Tactile stimuli also demonstrated the hyperexcitability of the anterior horn cells in the segment of lesion. If the back was slightly scratched or tickled with a pin, as over the shoulder or scapular area, continuing activity in the spinal extensors at the lesioned segment was often precipitated, but very rarely in the nonlesioned segment of the same subject. Thus impulses from touch and light pressure receptors in skin also find the most responsive anterior horn cells in the segments of lesion.

Occasionally we found a motor unit which fired in synchrony with inspiration or expiration; such a unit was invariably situated in the lesioned segments. Apparently such segments are hyper-responsive also to impulses from bulbar and pontine centers.

Interpretation of experiments.
The following general conclusions

may be drawn from these experiments as regards to motor activity in lesioned segments.

1. An osteopathic lesion is associated with a segment of the spinal cord which has a low motor reflex threshold, i.e., it represents a hyper-excitable segment of the cord. At least in the lesioned segments studied by us it may be said that the balance has been shifted too far for too long toward the excitatory side.
2. The lowered reflex thresholds are demonstrable independently of the related spinous process. Even though changes in the palpable characteristics and in pain sensitivity of the spines are important diagnostic features, they are apparently secondary to other, more fundamental alterations in the cord. This aspect will be discussed later.
3. The lesion represents an anterior root at least some of whose motoneurons are maintained in a state in which they are relatively hyperexcitable to all impulses which reach them. In a severe lesion many of the motoneurons are so close to threshold, even when the subject is at rest and reclining comfortably, that it requires very few additional impulses from the neurons which synapse with them to trigger those motoneurons into overt activity. Those additional impulses may come apparently from almost any source; the spinous process is but one such source.
4. The lesion, therefore, is to be conceived, not as a radiating center of irritation, spreading excitation to other segments, but rather as a segment upon which irritation is focused. It represents a place in the cord where barriers to motoneuron excitation have been lowered and which, therefore, channelizes impulses into muscles receiving motor innervation from that segment.

Basis for segmental hyperexcitability.
What is the basis for this segmental hyperexcitability? What keeps the motoneurons of the lesioned segment "on edge," that is, at a high level of subliminal excitation? These anterior horn cells can be maintained in this facilitated state by continuous and excessive bombardment from some untiring source or sources.

The source of impulses.
What are the untiring sources of impulses with which the anterior horn cells in the lesioned segments are continuously and excessively bombarded? First, their excessive activity is apparently associated with postural, mechanical, and articular derangements. Second, it must be recognized that they are apparently a highly stabilized and chronic source. Reflex thresholds in segments of lesion have been found to be very constant over periods of months and even years. Third, it must be recognized that they are probably highly localized, often restricting their facilitating effect to only one or two segments.

The sources which, in our opinion, most closely fulfill these qualifications are the proprioceptors, i.e., the stretch, tension, and pressure receptors in the muscles and connective tissues.

First, postural, mechanical, and articular derangements unquestionably cause increased fiber-length or tension in the muscles and tendons on at least one side of the articulation in question. The proprioceptors are highly sensitive to changes in fiber-length or tension.

Second, they are the nonadapting type of receptor. They keep firing impulses into the cord via the dorsal root fibers as long as they are under tension and at frequencies which are proportional to the tension. The higher the tension, the higher the afferent bombardment for as long as the tension is maintained.

Third, the afferents from proprioceptors not only have segmental distribution, but they specifically influence the activity of the muscles to which they are most closely related or in which they are situated. This specificity extends not only to the muscles themselves, but to specific muscle heads. It is thought that the muscle spindle cells reflexly influence only the muscle fibers in their immediate vicinity. In this way, highly localized, vicious cycles of irritation may be set up.

We, therefore, believe that these receptors play a prominent role in maintaining segmental hyperexcitability in areas of lesion. As a result of the continuous barrage of impulses which they fire into the cord at their level, the anterior horn cells of the corresponding segment are maintained in a state of chronic facilitation — at a high level of subliminal excitation, even during rest.

Effects of chronic facilitation.
In these segments, therefore, it may be said that the normal "insulation" which keeps the efferent neurons from firing in response to every impinging impulse has become worn. Since under normal conditions of life, requiring constant adjustment to the external and internal environments, requiring motion and the maintenance of the erect posture, so many impulses from so many sources are constantly impinging on the motoneurons, in all segments of the cord, that those which are already facilitated, as in the lesioned segment, will inevitably be more active than the other. The muscle fibers to which they are connected will then be excessively high in tone. If maintained for sufficient periods of time this hypertonus would lead to textural, morphological, chemical, and metabolic changes which may, in turn, become secondary and chronic sources of irritation.

Other neurons.
We have thus far discussed only the motoneurons and alterations in motor reflex activity in areas of lesion. What of the other efferent nerve fibers and the organs and tissues which they innervate?

Our experimental studies have demonstrated that closely and quantitatively correlated with lowered motor reflex thresholds are three other features of the lesion: (1) Alteration in the texture of the tissue overlying the spinous process, (2) lowered pain threshold, and (3) increased susceptibility to trauma.

1. Tissue texture: As is well known to osteopathic physicians, there are striking changes in the texture of the tissues over the spines of lesioned segments. It was found that the degree of change in tissue texture was so closely related to the degree of lowering of motor reflex thresh-

old from the normal that Denslow, through palpation of subjects prior to each electromyographic determination of reflex threshold, was able to predict with remarkable accuracy the reflex threshold of each segment.

It is probable that these changes in texture are due to local changes in vasomotor activity, fluid balance, capillary permeability, trophic factors, and other features which are directly or indirectly under the influence of the lateral horn cells of the sympathetic nervous system.

2. Pain threshold: A direct correlation was found between motor reflex threshold and segmental sensitivity to pain. As is well known, the spines in lesioned segments are much more tender than those in normal segments. In other words, it is easier to reach the "consciousness" of the patient, i.e., the cerebral cortex, through the lesioned segment than through the nonlesioned. This, we interpret as signifying a facilitation of the spinothalamic fibers.

3. Susceptibility to trauma: It was found that if one applies equal mechanical irritation (measured impacts) to the spinous processes of lesioned and nonlesioned segments, the former may remain painful for several days, whereas the subject soon forgets which of his normal spines received the pounding.

We may conclude from these correlations with motor reflex threshold that neurons other than the anterior horn cells may also be facilitated and maintained in a state of hyperexcitability in the lesioned segment. This appears to be true, at any rate, of certain of the preganglionic fibers of the sympathetic nervous system and of the spinothalamic fibers conveying pain sensation to the higher centers.

Experiments are now in progress to establish the degree of involvement of neurons of the sympathetic nervous system. Dermatomal alterations in sweat gland activity are being determined by measuring the electrical conductivity of the skin in lesioned and nonlesioned segments. We are measuring alteration in the activity of sympathetic fibers controlling vasomotor activity by electrical measurements of skin and deep muscle temperature. Although these studies are still in a preliminary stage, it has become evident that sympathetic activity in the skin is altered in lesioned areas and that instruments used for the measurement of these peripheral changes, and others which are contemplated, will in one form or another become valuable diagnostic aids. They are much more sensitive than fingertips and certainly easier to standardize.

There is no reason to doubt that lateral horn cells which influence specific visceral functions are fundamentally similar to those controlling the sweat glands. A project, in collaboration with Dr. D.E. Drucker of the Department of Physiology, is under way for the objective and precise determination of alterations in various visceral functions resulting from acute experimental spinal lesions in animals. The effects on visceral function, in normal unanesthetized dogs, of lesions in segments related to the viscus under examination will be compared with the effects of similar lesions elsewhere. At present, these investigations are limited to a study of renal blood flow, glomerular filtration, and tubular secretion. The kidney was selected for the first such investigation because methods for quantitative study in normal animals and humans are highly developed and because of the clinical significance of renal blood flow and renal metabolism in connection with such entities as hypertension. Similar studies upon other visceral organs are projected for the near future. It is hoped that from these studies will emerge a clearer understanding of the relations of the osteopathic lesion to visceral disease.

Characterization of the lesion

On the basis of the experimental studies so far, I believe we are ready to attempt a characterization of the osteopathic lesion in terms of basic neural mechanisms. Let us first summarize our general conclusions.

1. Normally, efferent neurons are kept from firing in response to every impulse that reaches them by the fact that a relatively high level of subliminal excitation — or facilitation — must be established, by other impulses converging upon them, before the firing point is reached. This requirement serves as a sort of insulation.

2. In the lesioned segment this insulation has been weakened. A large portion of the efferent neurons are kept near the firing point (facilitated), even under conditions of rest, by chronic afferent bombardment from segmentally related structures.

3. Proprioceptors are undoubtedly an important source of this bombardment, but any segmentally related structure may be such a source. A pathological viscus, or a cutaneous trigger spot, or any other inflamed or irritated structure which concentrates its afferents in one or a few dorsal roots may be responsible for more or less tonic facilitation. (The close relation of the osteopathic lesion to referred pain mechanisms is clear, but space does not permit a discussion of this most important aspect.)

4. The firing process in the facilitated efferent neurons may be completed by any impulses impinging on those neurons, whether the source of those impulses be the cerebral cortex, postural and equilibrium centers, bulbar centers, cutaneous receptors, or others. Should this superimposed bombardment be sufficient and enduring, the facilitated neurons (and the organs they innervate) may be maintained in a continuous state of excessive activity.

5. The state of facilitation may extend to all neurons having their cell bodies in the segment of the cord related to the lesion, including the anterior horn cells, preganglionic fibers of the sympathetic nervous system, and apparently the spinothalamic fibers.

6. Because a structural defect, an osteopathic lesion, sensitizes a segment to impulses from all sources, and for reasons previously given, the lesioned segment is to be considered not a radiating center of irritation, but rather a neurological lens which focuses irritation upon that segment. Because of the lowered barriers in the lesioned segment, excitation is channelized into the nervous outflow from that segment.

7. It is a truism in neurophysiology that when something is excited, something functionally related is simultaneously inhibited. Although in our studies we have not yet directed attention to this aspect, it cannot be doubted that facilitation in the segment of lesion also extends to

neurons exerting inhibitory influences upon other neurons or organs.

It may then be concluded that: *An osteopathic lesion represents a facilitated segment of the spinal cord maintained in that state by impulses of endogenous origin entering the corresponding dorsal root. All structures, receiving efferent nerve fibers from that segment are, therefore, potentially exposed to excessive excitation or inhibition.*

Manipulative Therapy

We come now to the last question: What, basically, does manipulative therapy do? Here, we can only guess, but at least our guesses are based on sound, experimentally established hypothesis.

Manipulative procedures applied by osteopathic physicians induce relaxation of muscle which has been maintained in a continuously contracted state and which, as a matter of fact, may not be able to relax spontaneously, even when excitation is removed (contracture). The increase in muscle-fiber length eases the tension on the proprioceptors in the muscles and tendons, bringing about at least a temporary diminution in afferent bombardment of that segment of the cord.

Since the excessive tendinous and muscular tension produced around a joint, let us say, by some bony displacement tends reflexly to produce more tension, the manipulative easing of tension breaks a vicious cycle.

Still another type of vicious cycle may be in operation and be broken by manipulative therapy (Fig. 1). Through overexcitation of sympathetic fibers in the segment of lesion, visceral pathology may be established. The anterior horn cells may then be subjected to additional bombardment with impulses conveyed by visceral afferents, thus causing exaggeration of the somatic lesion which, in turn, further irritates the viscus. Manipulative relaxation of the muscles may break this cycle, too, through diminution of proprioceptor discharge into the cord. Even a brief respite from this irritation allows better opportunity for the natural healing processes to operate.

By manipulative rearrangement of the skeleton and through postural adjustments, the original cause of the strain, that is the excessive tension on muscles, tendons, and ligaments, may be eliminated and the beneficial results made more lasting.

This is unquestionably an oversimplified version of the basic effects of manipulation, but it certainly will serve as a working hypothesis, as a guide to further experimental investigation.

Speculations

Assuming the importance of the proprioceptors in the lesion mechanism, it must be kept in mind that any segmentally related structure which sends afferents to the spinal cord may be an important participant in the establishment or maintenance of the lesion. In fact, through the network of interneurons, practically any afferent, segmentally related or not, may exert some influence.

To all these sources of impulses must be added the suprasegmental sources — all the higher centers, from medulla to cerebral cortex — which contribute to the descending spinal tracts. Many of these are continuous and highly variable sources of impulses. They exert their influence — excitatory or inhibitory — upon efferent neurons at every level of the spinal cord.

It is, indeed, most important to keep in mind that the efferent neurons do represent final common paths shared by a host of impulse sources, in addition to those associated with joint and supporting tissues. In this light, it is apparent that the articular derangement or the osteopathic lesion cannot be conceived as the *cause* of disease; rather it is one of many factors simultaneously operating.‡ The lesion is a most important factor — it is a sensitizing factor, a predisposing factor, a localizing factor, a channelizing factor. The lesion sensitizes a segment of the cord, lowers the barrier, facilitates — without necessarily producing symptoms, although signs of its presence may be demonstrated by the osteopathic physician. Sufficient additional excitation has to be superimposed upon that from articular and periarticular origins. This is not to minimize the importance of the osteopathic lesion. On the contrary it is to widen the concept. For one thing, it certainly points up the tremendous contribution that osteopathic diagnosis and therapy can make to preventive medicine.

To osteopathic physicians there is, of course, nothing unfamiliar in the practical aspects of this concept. One patient has relatively severe lesions, yet is sympton-free, pain-free, and not readily subject to fatigue, etc; another patient with very similar lesions, on the other hand, may be subject to serious disturbances directly related to those lesions. Further, the lesions of the first patient may "act up" under certain circumstances, and then subside into "quiescence" again. Why? What accounts for the difference between such patients, and between the "acting-up" and "quiescent" periods in the same patient? In our opinion and, I believe, implicit in the osteopathic concept, one important basis for the difference lies in differences in the amount of nervous excitation continuously impinging on the efferent neurons of the lesioned segments, over and above that from the muscles and joints. The lesion operates in different contexts with different effects.

Given an articular disturbance which, through the mechanisms discussed above, determines the *location* of the low threshold segments, then the severity of the lesion, the associated pathology, and the response to treatment will be to a great extent, often to a decisive extent, determined by how much additional neuron pressure from other sources is chronically present. Such pressure may be present upon all the segments, but because of lowered synaptic barriers, the effects will be exaggerated at the lesioned segment. The lesion not only focuses; it magnifies.

This superimposed excitation may come from any of the sources previously enumerated, and others, which converge upon the anterior horn cells and the other efferent neurons: the cortex, the basal ganglia, cerebellum, vestibular nuclei, bulbar center, the eyes (via the

‡In fact, it is doubtful whether there is ever a single cause of any effect, whether there is ever an isolated etiological factor in any clinical entity. Each factor operates in the context of many factors and produces certain effects only in a certain combination of factors.

tectospinal tracts), or any steady, tonic source of impulses.

Since all these sources may directly affect, favorably or unfavorably, the lesion and its associated phenomena, they are all properly within the province of the osteopathic physician. All of them may contribute to the lesion and to its effects on total body economy. Important as is the structural factor, treatment of it alone is not to treat the patient as a whole and would be, if I interpret it correctly, a corruption of the osteopathic concept.

I shall try to illustrate with one source of bombardment which is of very general significance, namely, the cerebral cortex. As previously indicated, the words "tense," "high-strung," "jumpy," "keyed-up," "on edge" are more than figures of speech. They bespeak the well-recognized fact that psychic stress, emotional imbalance, environmental strains, etc., influence and are reflected in motor activity — an increased muscular tone and hyper-responsiveness, in generally lowered reflex thresholds. A familiar illustration is the exaggerated knee jerk of a tense individual. (Other types of imbalance may, of course, have depressing or inhibitory effects, resulting in fatigue, hyperreflexia, inertia and other symptoms.)

These are obviously due to impulses passing down the descending spinal tracts and impinging, directly or through interneurons, on the anterior horn cells and increasing their excitability and activity.

In a segment already sensitized by an osteopathic lesion the effects will be especially severe. Just as important is the fact that descending impulses may exacerbate the lesion and produce increased effects on segmentally related organs, may cause or intensify pain, and make the lesion less responsive to manipulative therapy. To treat only the structural source of bombardment is only to half-treat and to neglect a most important part of the lesion mechanism, and to take the lesion out of context. This does not mean, of course, that every osteopathic physician should become a psychiatrist, but he certainly must take into consideration the home factors, environmental factors, family relations, emotional adjustments, tensions, etc.

In this light the as yet unexplored relations of osteopathy to psychosomatic medicine become obvious. It is now well established that many organic ills, including angina pectoris, gastric and duodenal ulcer, gallbladder disease, mucous colitis, asthma and others, may be directly related to psychoneuroses, emotional imbalances, and anxieties. What factors determine the organic manifestation of the neuroses? The autonomic nervous system, of course, has regional representation in the cerebral cortex and the hypothalamus is under cortical influence. It has been thought that the unconscious may select the organ or organs to be affected. Without prejudging these and other theories, it would seem most profitable, clinically and experimentally, to explore the probability that the incidence and location of osteopathic lesions may be an important factor in determining the incidence and nature of psychosomatic ills. Certain aspects of this hypothesis are under experimental investigation in the Kirksville laboratories.

Summary

1. Some of the neural mechanisms involved in the osteopathic lesion, in its local and distant effects, and in manipulative therapy are examined.

2. The results of experimental investigations are presented which indicate that the lesion is associated with a segment of the spinal cord which is hyper-excitable to all impulses which reach it, and that the hyperexcitability may extend to any neurons having their cell bodies in that segment.

3. It is concluded that osteopathic lesion represents a facilitated segment of the spinal cord maintained in that state by impulses of endogenous origin entering the corresponding dorsal root. All structures receiving efferent nerve fibers from that segment are, therefore, potentially exposed to excessive excitation or inhibition.

4. Evidence is presented that the stretch and tension end-organs (proprioceptors) in the muscles and tendons are the most important source of afferent impulses which produce the changes in the cord that are associated with the osteopathic lesion.

5. The effect of the lesion as a predisposing and localizing factor is emphasized and discussed in relation to certain aspects of osteopathic practice.

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Reflex relationships of paravertebral muscles[1]

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Eble, John Nelson. *Reflex relationships of paravertebral muscles.* Am. J. Physiol. 200(5): 939–943. 1961.—The muscles of the back are shown to function reflexly in various antagonistic and synergistic pairs. Intertransversales muscles of opposite sides can act synergistically for ventral flexion or antagonistically for lateral flexion. Multifidus muscles of opposite sides act independently or synergistically only. There is a stronger reciprocal relationship between the multifidus on one side and the intertransversales of the other side than between multifidus and intertransversales of the same side. Inhibition of antagonists occurs with stimuli too weak to excite the agonists. The patterns of the spinal reflex responses of the paravertebral musculature to cutaneous stimulation change with regard to segmented level and to area of skin stimulated. Stimulation of dorsal skin provokes reflex contraction of the multifidus muscles. Stimulation of ventral skin provokes reflex contraction of the intertransversales muscles. A stimulus applied to a lateral skin area elicits a response in both members of this antagonistic pair. Moving the dorsal stimulus caudally from L-5 to L-6 results in a change of the reflex pattern from multifidus activity to intertransversales activity.

Historically there has been considerable controversy as to the role of reciprocal innervation of antagonistic muscles. Tilney and Pike (1) in a scholarly introduction distinguished between the English or reciprocal innervation school and the French or cocontraction school. Later experiments (2–5) have shown that both phenomena do occur and indeed are necessary for the variety of motions that the organism makes. Such early work had to do with the action of limb muscles but recently Kugelberg and Hagbarth (6) examined the "spinal mechanism of the abdominal and erector spinae skin reflexes." A more detailed analysis of these reflexes, particularly a separation of the components of the erector spinae mass, was made possible by methods we devised for a study of visceral-somatic reflexes (7). The present paper is a detailed study of reflex patterns of the abdominal and paravertebral muscles in the lumbar region as evoked by various somatic stimuli. We have recorded electromyographically the reflex excitation and inhibition of the following muscles: multifidus, intertransversales, longissimus dorsi, psoas and rectus abdomini.

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METHODS

Acute spinal rabbits for these experiments were prepared by section of the cord in the T-2 region as previously described (7). These rabbits remained useful for experimental purposes for 3–4 days and longer.

Electromyographic recording. Electromyograms were obtained on a Grass 8-channel electroencephalograph. The recording electrodes were simple insulated copper wires (32 PE), with tips scraped free of insulation. Each electrode was passed through a 20-gauge hypodermic needle and bent back to form a hook. The needle was inserted into the muscle to the desired depth and then withdrawn, leaving the hooked electrode in place. We found it convenient to solder two needles together so as to maintain the interelectrode distance constant at approximately 4 mm.

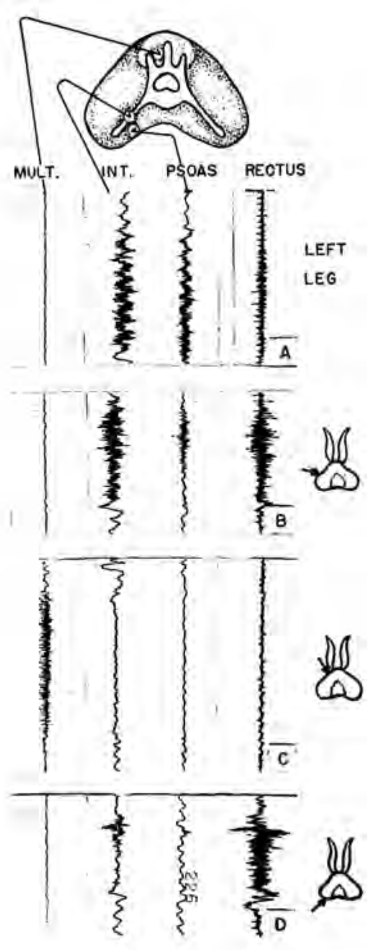
To permit easier placement of the electrodes into the posterior paravertebral muscles, a long skin incision was made in the mid-line of the back; for the accurate placement of electrodes into the psoas muscles a long abdominal incision was necessary. Electrodes were placed into the intertransversales muscles by either an abdominal or a dorsal approach.

These flexible paired electrodes were found to have several advantages. They did not impede the movements of the rabbits, nor did such movements cause any displacement of the electrodes from their position in the muscle tissue. Their range of pick-up would be expected to be between that of concentric needle electrodes and surface electrodes. Concentric needle electrodes were not found to have the necessary flexibility to remain precisely in place for a period of days or even hours. Surface electrodes, on the other hand, have too wide a range of pick-up for localization of the potentials necessary to distinguish activity in juxtaposed muscle groups.

It has been determined by careful checking of the placement of our electrodes by dissection at autopsy, that when two pairs of electrodes are in different muscle groups, for example the multifidus and longissimus, or intertransversales and psoas, the distance between them can be as little as 5 mm, and yet each will have a mutually exclusive range of pickup. This range approximates that found for concentric needle electrodes by Weddell *et al.* (8) but is considerably smaller than found for concentric needle electrodes by Basmajian and Latif (9).

RESULTS

Patterns of response of paravertebral musculature to cutaneous stimuli. Pinching the skin of the left leg of these spinal preparations results in a withdrawal motion of the leg and frequently a hunching of the back of the animal. The record of the accompanying electrical activity in the intertransversales, psoas and rectus muscles is shown in *A* of figure 1. Although not shown in the figure, the trunk reflexes to stimulation of the skin of a leg are always bilateral (but not symmetrical rather occurring predominantly on the homolateral side). The probable explanation for this deviation from the classic concept of crossed extension and ipsilateral flexion is the fact that the rabbit is a hopping and not a stepping animal, rather than changes in internuncial pathways induced by cord transection as suggested by Perl (10) for other species.



The cutaneomotor reflexes of the trunk appear to be highly organized, and show a variety of patterns which depend upon the site of stimulation. The stimulus in these experiments was simply the application of pressure to a fold of skin grasped between the thumb and forefinger. *B*, *C* and *D* of figure 1 show that, as the point of stimulation is moved dorsad or ventrad within a given dermatome, there is a change in the pattern of muscles responding. This change was observed in all of the rabbits tested; in each case the muscular response would seem to be appropriate for the withdrawal of the trunk from the noxious stimulus. Adequate increase of the intensity of the lateral and ventral stimulus (*sites B* and *D*) resulted in visible lateral and ventral flexion, whereas no such visible degree of dorsi-flexion was observed from the dorsal stimulus (*site C*).

Another example of the changes in pattern of paravertebral muscular response with changes of site of stimulus is shown in figure 2. As the locus of stimulus is moved caudad along a line slightly to the left of the mid-point of the dorsum the muscles responding change from multifidus to intertransversales. This change in the character of response is the result of a shift in the point of stimulus of just a few millimeters. Between these two points that give quite different responses, there is an area in which stimulation elicits a mixed response. This area of overlap of receptor fields extends for approximately two segments. At other times in the same animal a mixed response could be obtained by applying the stimulus at L-4 and at levels midway between L-5 and L-6. The kind of response to stimulation in this small critical area is dependent on factors other than the point of stimulation; visceral and proprioceptor afferent impulses, for example.

Patterns of response of paravertebral musculature to proprioceptive stimuli. For the application of the stimuli, the entire loin of the animal was gently grasped between the thumb and forefinger at approximately the level of L-3. When pressure was applied to one side or the other there was a lateral or side-bending of the animal with a stretching of the intertransversales muscles on the opposite side. As shown in figure 3, this was accompanied by a pronounced electrical activity in the intertransversales on the side contralateral to the pressure. (In contrast, pinching the skin at the same site elicited homolateral intertransversales activity, fig. 1). It should be

FIG. 1

Electromyographic recording of activity in paravertebral muscles as elicited reflexly by pinching skin of left leg, A, and of trunk areas indicated by small arrows. Stimulus to the leg resulted in withdrawal of leg, but the stimuli to skin of the trunk did not evoke a visible movement of the spinal animal.

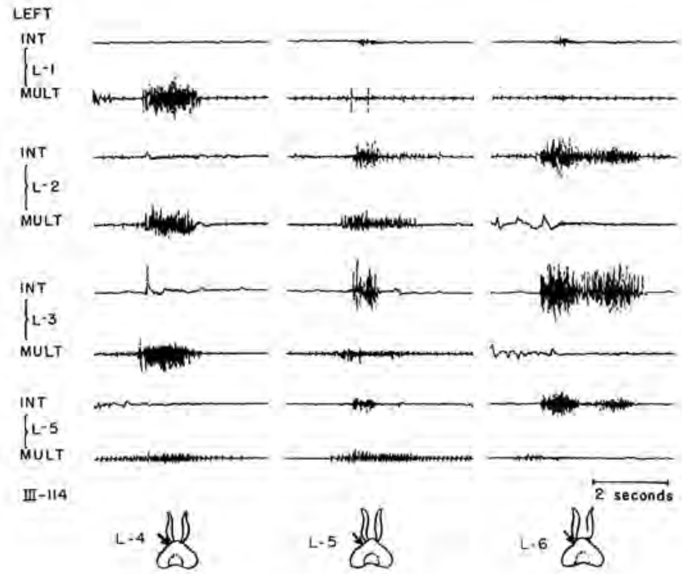


FIG. 2

Electromyographic record of activity in paravertebral muscles reflexly induced by dorsal cutaneous pinches at different segmental levels (segmental designations correspond to levels of spinous processes). As site of stimulation is moved caudad, the focus of reflex response also moves caudad but, in addition there is a change in the character of response, from dorsiflexion to ventral flexion. Stimulation at intermediate points results in a mixture of the two kinds of reflexes.

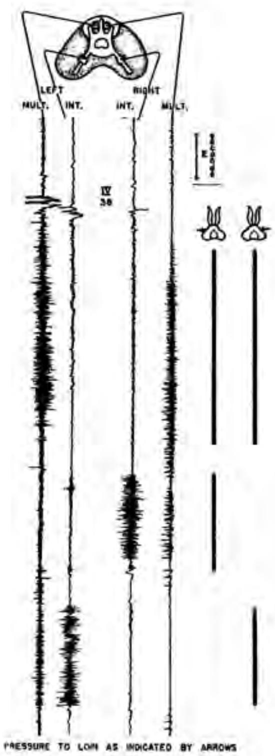


FIG. 3

Reflex response of paravertebral muscles to pressure (indicated at right of fig.) and stretch stimuli. When the fingers press bilaterally, stimulus is that of pressure to underlying skin and musculature, but when force is applied to one side only there is, in addition, stretching of muscles of opposite side.

noted that this reflex response to stretch in the spinal animal would not be expected in intact man. In the latter case proprioceptive impulses from such a mild and slow stretch of limb muscles have been shown not to produce a reflex discharge of the motor neurones to the muscle that is stretched (14, 15).

When the pressure was applied bilaterally, a different pattern of response resulted. In this case there was no side bending and consequently no stretching of the underlying tissues. The predominant response was activity in the multifidus muscles of both sides as shown in figure 3.

Reciprocal relationship of intertransversales and multifidus muscles. Since, as shown in figure 3, bilateral pressure elicited bilateral activity in the multifidus muscles we questioned why the unilateral pressure applied to the same area did not produce homolateral activity. An answer to this question was sought through examination of the interrelationships of multifidus and intertransversales muscles in the next 11 rabbit preparations studied.

For the demonstration of reciprocal relationships it is necessary that tone exist in the antagonistic muscles. Therefore, since the loin muscles of these spinal rabbits were normally electrically quiet, it was necessary to elicit the necessary tonus by a sustained stimulus. An appropriate cutaneous stimulus was used for this purpose.

Figure 4 shows how a skin stimulus which elicits multifidus activity on one side inhibits pre-existing intertransversales activity on the opposite side. This occurs even when the stimulus is of insufficient intensity to excite the underlying multifidus as shown in the latter part of the inhibitory period. The absence of electrical activity in the multifidus during this period suggests that the inhibition of intertransversales is the direct result of the stimulus and not due to afferent impulses

73

arising from the shortening or the increase in tension of the multifidus muscles.

This reciprocity can be demonstrated in both directions as shown in figure 5. Inhibition of tonic multifidus activity can be achieved with stimuli which elicit activity in intertransversales muscle groups.

In the light of these demonstrated reciprocal relationships between the intertransversales and multifidus muscles, the results shown in figure 3 are clarified. The

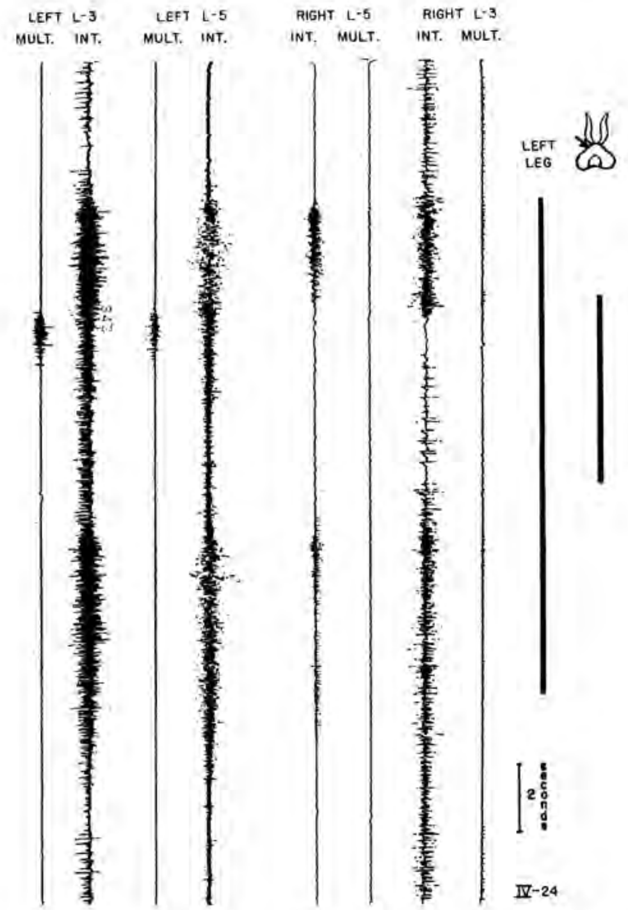


FIG. 4

Interaction of reflex responses of paravertebral muscles to pinching of skin at 2 sites, as indicated on right of fig. Inhibition of tonic intertransversales activity by pinching skin of dorsum is greater on contralateral side. In the early part of inhibitory period, pinching of skin of the dorsum is of such intensity as to elicit multifidus activity. Such intensity of stimulus is not necessary to produce inhibition as is shown in latter part of inhibitory period.

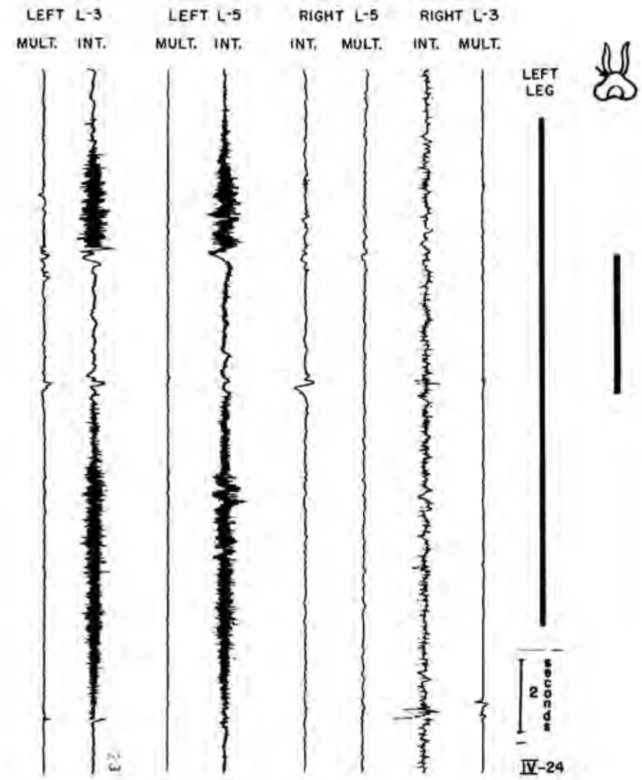


FIG. 5

Interaction of reflex responses of paravertebral muscles to pinching of skin. Inhibition of tonic activity of multifidus by pinching skin of left leg is, in a sense, the reverse of pattern shown in fig. 4.

unilateral pressure in fact involves two opposing stimuli. The first (pressure) causes reflex excitation of the underlying multifidus. The second (side bending and stretch) causes reflex excitation of the contralateral intertransversales which, by the reciprocal relationships shown in figures 4 and 5, reflexly inhibits the multifidus. The reciprocal inhibition predominates over the direct excitation of the multifidus. The reflex stimulating action of pressure on the multifidus is evident only when pressure is applied bilaterally and there is no movement of the animal to initiate the inhibitory reflexes.

Interrelationships of paired intertransversales muscles and paired multifidus muscles. In 5–10 trials in each of 15 rabbits we were unable to find a combination of stimuli to the skin of the dorsum of both sides which would show reciprocal relationships of the multifidus muscles of opposite sides. All combinations of bilateral stimuli to the skin of the dorsum resulted in simultaneous activity of the multifidus muscles on both sides (cocontraction).

With the intertransversales muscles, however, both cocontraction and reciprocal innervation were observed. As shown in figures 1 and 6, pinching the skin on the left evokes a reflex response in the intertransversales on the ipsilateral side. If, during a period of maintained stimulus to one side and a resulting tonic activity in the intertransversales on that side, a stimulus is applied to the skin of the opposite side inhibition of the tonic activity results (fig. 6 only). In 70 trials in five rabbits we have been unable to find a combination of stimuli which would result in neutralization, that is absence of activity on both sides. Only inhibition of tonic activity on one side by alteration of the relative intensity of the two stimuli or, simultaneous but decreased activity on both sides have been observed. The simultaneous activity is elicited by stimuli such as pinching the tail or the skin overlying the midline of the abdomen. It is symmetrical in these instances, but is greater on the homolateral side if the stimulus is moved laterally on the abdomen or from the tail to the skin of the leg. These different patterns of response to various stimuli were so reproducible that they served as a check on the correct placement of the electrodes, thus permitting their withdrawal and replacement early in the experiment, if necessary.

DISCUSSION

Though undertaken independently, this work is in part an extension of the studies made in intact man by Kugelberg and Hagbarth (6). We have divided the erector spinae mass into its component parts and have shown that the abdominal and erector spinae skin reflexes are even more complex than was evident from the experiments of Kugelberg and Hagbarth. We, by using spinal preparations, and they, by accurate measurement of latent periods, have shown that these complex reflex reactions are mediated by the spinal cord. In the spinal preparations, however, it was possible to use more prolonged stimulation than could be used in studies with human beings. Continuous stimulation in spinal preparations is a better approximation of many pathological conditions, such as those that produce abdominal rigidity. The complex patterns of muscular response to various cutaneous, visceral and somatic stimuli which occur at the spinal cord level are integrated with the pre-existing posture of the animal and with other contemporaneous stimuli.

We have shown examples of three kinds of muscle activity integration at the spinal level: relatively independent activity of muscle groups (fig. 1); cocontraction of antagonistic muscle groups (the intertransversales muscles of both sides, fig. 4), and reciprocal relationships between agonists and antagonists (fig. 3–6). Cooperation between anatomically antagonistic muscles in regard to time and magnitude of response was adjusted with great variation in our preparation by strictly spinal

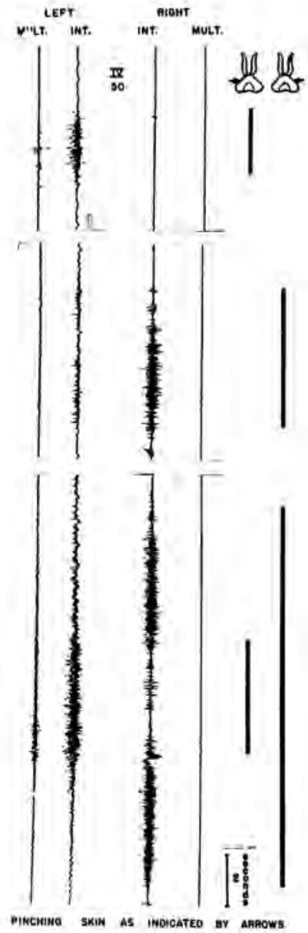


FIG. 6

Interaction of reflex responses to skin pinches on opposite sides. Response of intertransversales to pinching skin of side is homolateral, but contralateral when the stimulus is pressure, as shown in fig. 3. When stimuli are applied to opposite sides simultaneously their intensities can be adjusted so as to result in inhibition of one side or the other, or in simultaneous contraction of both sides, but not in total inhibition of both sides (as shown for multifidus and intertransversales of opposite sides in fig. 4).

mechanisms. Cocontraction of the intertransversales of opposite sides results in splinting with regard to lateral movement of the trunk, but is an effective force for ventral flexion.

With reference to the activity of antagonistic muscles during voluntary movement, Barnett and Harding (11) emphasized that their findings "may represent the resultant of two opposing effects—the central inhibition of the antagonist muscle and a reflex contraction due to stretching." The cutaneous stimuli that we applied were not of adequate intensity to produce motion which would cause stretch and, therefore, produced only one of the two effects. Our experiments then, are analogous to those of Sherrington (12) in whose experiments the tendons of the muscles tested had been detached from their insertions, so that no stretching of the antagonist was produced when the prime mover contracted. The same conditions obtained in our experiments because the electromyographic detection permitted recording of muscular activity of such small magnitude.

Kugelberg and Hagbarth (6) observed reflex responses at distant segments which alternated with bursts of response in the optimal area. We did not observe this seemingly reciprocal relationship between adjacent segments, but rather a radiation of reflex response to adjacent segments without any discernible period of inhibition. This difference is probably attributable to the differences in mode of stimulation—short bursts of electrical stimulation as opposed to prolonged mechanical stimulation. The diminution of activity in both antagonists and agonists when two opposing stimuli are applied that was reported by Kugelberg and Hagbarth (6) was also observed by us. Complete nullification was observed when the antagonistic muscle groups were intertransversales of one side and multifidus of the opposite side (fig. 4). Reduced activity only was observed when the antagonistic muscle groups were the intertransversales of opposite sides.

The muscles of our preparation are electrically quiet in the resting state as has also been shown in other instances (12–14). Consequently, to demonstrate reciprocal relationships it was necessary to induce tonic activity by stimulation. This fact would indicate that the normal role of reciprocal innervation is to modify the excitability levels of appropriate neurons rather than to diminish activity in antagonist muscles which experimentation shows to be normally nonexistent.

It is quite likely that reciprocal inhibition of muscles is as important in the production of postural abnormalities by pain in abdominal and/or spinal structures as is reflex excitation. The use of such reflex inhibitory phenomena is well established. As long as 70 years ago Beevor (16) reported a method of relaxing knee extensors by making the patient violently flex the knee against resistance. It is hoped that the more precise information on the relationship of the paravertebral muscles shown in these experiments may be helpful in extending this kind of treatment and examination to the muscles of the back.

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