

Original Articles.

DRY HOT AIR AS A THERAPEUTIC AGENT,
WITH DEMONSTRATION OF THE BODY
TREATMENT.¹

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Mr. President and Gentlemen — Dry hot air is but little known to the profession at large, hence in addressing a gathering of general practitioners it becomes necessary to treat the subject from a general rather than a technical standpoint. Like all new therapeutical measures, it has had to pass through an experimental stage during which its employment was purely empirical, and its place in the estimation of the masses of the profession was the unenviable though inevitable one occupied by all new measures the use of which is empirical.

Those of us who were sufficiently impressed by its early promises to continue the study of its remedial influences under varying pathological conditions, however, have become convinced that in it we possess an agent capable of exerting great power for good in many directions, and the result of this continued study has been the accumulation of data sufficient to rescue the employment of the measure from the mists of empiricism, and to place it today upon a firm basis of rational indication in a large number of diseased states.

The first question which logically comes up for consideration when a new therapeutical agent appears is, "How does it influence the human organism? What is its physiological action?" The question which *naturally* assumes the most attractive aspect, however, is "What will it do in a curative way?" and as in the case of the remedy under discussion the actual course of its therapeutical evolution was according to the *natural* rather than the *logical* order, we will, if you please, follow history, and first glance briefly at some of the clinical results producible and afterward consider the manner of their production.

Rheumatism was the first disease to the management of which hot air was applied, and it is in the treatment of this disorder that it has gained some of its greenest laurels. One of the most important points to be taken into consideration in judging of the efficiency of hot air, or any other element of treatment in this disease, is the very common error of diagnosing as rheumatism conditions of an entirely different nature. Rheumatism has been made to bear a vast deal of undeserved opprobrium. At least three fourths of the cases which have come under my observation with this diagnosis have not been rheumatism at all, and, furthermore, many of them have involved the practical point of being disease processes which do not respond to anti-rheumatic therapeutics. True rheumatism, however, has been rescued by dry hot air from the category of diseases the treatment of which has long been

regarded as a reproach to the profession, and the affection can now be as satisfactorily and positively cured as any other disease, not excepting malaria.

It is always wise, and usually necessary, to give some salicyl compound with the hot air. This agent will always relieve the pain alone, and some cases are susceptible of cure with it alone, but the salicyl compounds with hot air effect a cure in nearly all cases, and I regard their administration as imperative.

Briefly, the results of the use of hot air in rheumatism are as follow:

First, immediate relief of pain, however severe, which relief may be rendered permanent by repeating the treatments as often as the pain becomes troublesome; every four hours, if necessary.

Second, shortening of the duration of the disease, which usually lasts only from five to ten days when hot air is thoroughly administered in combination with salicylic acid.

Third, lessening of the liability of cardiac involvement because of the rapid control obtained over the pathological condition, whereby the infection is inhibited from further attacks upon other tissues.

Fourth, the lessened number and quantity of the drugs which it is necessary for the patient to ingest, because of the increase produced in the efficiency and intensity of their action at the seat of infection; hence rendering it possible to avoid drug intoxication.

Fifth, in many cases which prove intractable to other measures its employment will render possible the extinction of the trouble.

Sixth, when properly and judiciously applied, its use is never productive of any vicious after-effect; on the contrary, the patient's general condition is immediately and greatly improved.

Sprains are often extremely resistant to the usual therapeutical methods, and recovery is not infrequently a matter of from six to eight weeks. When one of these injuries is brought under the influence of hot air, within four or five hours after it has been sustained all traces of the trouble will ordinarily have disappeared in from two to four days. Instead of weeks of painful confinement we have days only, and as the pain is relieved immediately the patient does not suffer. These two results of its application entitle hot air to a place in the first rank of remedial measures appropriate to this condition, if not to the first place. The effects of hot air in this situation appear magical at first sight to those who are not clinically familiar with the agent, yet they have been obtained by the speaker and others time after time within the last four years. The treatment may be applied as often as the pain shows evidence of returning, no matter how frequently, without any bad effect upon the patient. In this way he can be kept in a condition of constant comfort.

Arthritis deformans has been hitherto, under ordinary remedial measures, the despair of the medical profession. In hot air, however, we have an agent which alone will cure many of these cases, and which, in combination with static electricity and other rational therapeutical measures, will restore the majority of the victims of this disease to useful and comfortable lives. The pain is not so susceptible of immediate relief by dry hot air treatments

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as it is in rheumatism and sprains, but electricity, in the form of the static, faradic and high-frequency currents, supplements hot air very satisfactorily in this field. To secure the best results we ought to combine the other methods of physical therapeutics with hot air, a few drugs and dietary regulation.

The progress of the disease toward recovery is very slow, but usually fairly steady when estimated in periods of weeks. From six months to a year is the time usually required to produce a cure, although I have seen cases cured in a month; I have also had them require two years. In a disease so intractable to any treatment as this, however, it is a matter upon which we may most sincerely congratulate ourselves that we are at last in a position to promise the majority of our patients relief from their troubles; and this we may now safely do.

Pneumonia is another disease in which we frequently need all the therapeutical assistance that we can secure, and hot air is one of the most potent of agents in the treatment of this disease. A local treatment applied over the affected lung will relieve the pleuritis at once and remove all signs of consolidation in from two to five days. The patient begins to improve immediately after the first treatment, and, although the course of the disease is not shortened, the severity of its symptoms is very greatly decreased. This rapid removal of the exudate does away with the danger of heart failure from overdistention, and the getting rid of the pleurisy does away with a large proportion of the respiratory oppression and cough, whereby the patient's comfort is greatly increased. The happy influence of the body treatment upon the eliminative function will do more to relieve the profound systemic toxemia sometimes encountered than any other measure now known.

Local septic infection, proceeding from ordinary traumatism or surgical operation, responds most kindly to dry hot air. In the ordinary instances where the infection begins in a hand or foot, if the case comes under treatment before the infection has involved the lymphatics of the joint which connects the limb with the trunk, the local treatment will usually be entirely effective in producing a cure, and the patient will begin to improve after the first treatment. I have seen several cases of local infection, coming under treatment early, get well in three days. If the infection has gotten into the lymphatics of the trunk, however, the influence of the body hot air treatment upon the organism at large will have to be invoked. I have up to the present time treated fifteen cases of local sepsis, of different degrees of severity, and every one of them has recovered. If any structure has become so profoundly involved in the destructive process as to render regeneration impossible, suppuration will ensue as a matter of course, and surgical interference will become a necessity. Hot air will not remove pus. It will, however, in at least a majority of cases, secure the recovery of the patient either with or without surgical interference, and in so far it is of inestimable value in this condition.

The symptoms of chronic and acute nephritis are frequently very amenable to thermotherapy. The dropsy, oppression of breathing, mental somnolence, and cardiac disturbance of the acute exacerbations of the disease will sometimes diminish

during the first treatment and before the patient has left the apparatus. I have seen cases in which all the albumin had disappeared from the urine in three weeks, and as far as examination would show the patient had been restored to perfect health. How long this happy condition will continue it is of course at present impossible to say, but if the symptomatology does return the treatment can be applied again, and any nephritic would be glad if he could be maintained in apparent health by taking a course of hot-air treatments two or three times a year if necessary. The excretion of urea and the total output of urine are usually enormously augmented by the body treatment in this disease.

Lack of time forbids my discussing the other conditions in which hot air is useful at any length, and I will merely mention those in which it has been demonstrated to be of value, as follow:

Peritonitis,	Plumbism,
Pleuritis,	Lithemia,
Synovitis,	Varicose ulcers,
Nervous debility and exhaustion,	Neuralgias and myalgias,
Neuritis,	Alcoholism,
Tuberculosis of joints,	Muscular adhesions,
Fibrous ankylosis,	Osteomyelitis,
La grippe,	Periosteitis,
Typhoid fever,	Myositis,
Gouty diathesis,	Dysmenorrhea,
Atheroma,	Gangrene,
Syphilis,	Angina pectoris,
	Cholelithiasis.

With these clinical results before us we will now, if you please, take up the physiological action of the agent, which when considered in connection with the pathological conditions obtaining in these different diseases will elucidate the *modus operandi* by which the curative phenomena are induced, and furnish us with a key to the rational indications for its therapeutical employment.

There are two varieties of hot air applications: one where only the part affected is treated, and which is denominated the "Local treatment"; and the other where the greater portion of the body surface is subjected to influence, and which is denominated the "General" or "Body treatment." The physiological actions of these two varieties of applications differ from each other in degree and to a certain extent also in kind, and we will consider first, if you please, the physiological influence of the local treatment.

This therapeutical measure affects physiological function in two ways: First, by a direct stimulation of cell metabolism in the part treated, due to the raising of its temperature *en masse*; and, second, by a reflex acceleration of cell nutrition set up by the stimulating influence of the heat upon the numerous nerve endings in the skin.

It is, of course, not possible to raise the temperature *en masse* of one portion of the body very much higher than that of another portion, but by placing the bulb of a clinical thermometer at the bottom of a deep sinus and then applying a hot air treatment, it has been demonstrated that an increase of several degrees Fahrenheit can be induced. This is enough to accelerate oxidation processes very perceptibly.

In diseases characterized by the presence of pathogenic micro-organisms in the part treated, as local septic infection and pneumonia, the inhibitive influence of this element of the physiological action

upon the growth and activity of the germs, whereby they are rendered more susceptible of attack by stimulated leucocytosis and cell metabolism, is very evident. It has been suggested that the germs in these cases were directly destroyed by the heat. This view, however, is improbable, and there is no experimental or clinical evidence available indicating that it is possible to raise the temperature of any portion of the body sufficiently high to produce this result.

Through the reflex influence is obtained an emphatic local hyperemia, which, together with the stimulation of the trophic nerve supply of the part treated, results in greatly increased local nutrition.

Copious perspiration appears upon the region treated, and in greater or less degree upon the rest of the body. The secretion is strongly impregnated with fatty acids whatever the disease from which the patient is suffering, or even if he has no disease at all. If a toxin is circulating in the blood, a certain amount of it will be eliminated with this secretion.

To these profound influences upon the circulatory functions of the part whereby stasis is relieved, is probably due the powerful influence of dry hot air treatments in relieving pain and swelling.

The general body temperature and pulse are but rarely much affected. Patients frequently exhibit an increase of a fraction of a degree in the former and eight or ten beats per minute in the latter, but nothing to influence the general metabolic functions markedly. That local hot air applications are sometimes capable of exerting profound reflex influence upon distant parts, however, was demonstrated in a case reported by Walsh. The patient had eczema of both hands; one only was subjected to the treatment, yet both got well. Cases also have been reported where pains in a limb on one side of the body have been relieved while the corresponding limb on the opposite side was being treated.

It will be observed that all of these effects tend to greatly increase the assimilation of remedies in the tissues subjected to their action.

The physiological action of the body treatment is predominantly reflex through the spinal sympathetic, the area of skin treated being so great that the capillary circulation is able to dissipate the heat before it penetrates deeply enough to exert its action directly to any great extent, herein differing from the local application.

Microscopical and chemical examinations, made in connection with patients under treatment by the writer, have demonstrated that the following phenomena are susceptible of immediate induction by the body hot air treatment.

First, if hyperleucocytosis is not already present, the number of white blood corpuscles is increased in different cases from 15 to 50%. If it is present, the increase is usually not so great, or it may be entirely *nil*.

Second, the red blood cells are increased from 10 to 20%.

Third, the quantity of urine passed in the twenty-four hours succeeding the treatment is usually increased from 25 to 100% over that passed in the twenty-four hours preceding. In a few instances, however, a decrease in the quantity has been observed.

Fourth, the quantity of urea excreted in the

twenty-four hours succeeding the treatment is increased from 15 to 60% over that excreted in the twenty-four hours previous.

These effects persist, with decreasing intensity, for from four to forty-eight hours and sometimes longer, the time varying in different diseases and with different patients.

It will be observed from the above that the beneficial effect of body hot air is not entirely due to the induction of hyperidrosis and superficial hyperemia, as is frequently stated, but that its influence involves phenomena of much greater profundity than would be explicable upon such an hypothesis.

When we consider the large number of pathological conditions in which the reconstructive functions are deficient, the modifications in the composition of the blood noted above assume an interesting significance; and when we think of the number and variety of diseases which are dependent wholly or in part upon the retention in the system of products of sub-oxidation, the sphere of action of the body hot air treatment, as indicated by its effect upon oxidation and the excretory function, becomes extended within limits of considerable magnitude.

The general phenomena induced by the body application are as follow:

The mouth temperature rises from 1 to 5° Fahrenheit, according to the length and intensity of the application and the susceptibility to stimulation of the individual patient's deep nerve centers.

The pulse is accelerated from thirty to fifty beats per minute, and is markedly increased in volume. If it was weak before treatment it now becomes strong. If the application is continued too long it loses its volume and strength, becoming rapid, small and soft, but sometimes retains its volume, becoming very soft and slow. Under these conditions the patient becomes dizzy, faint and nauseated.

The respiration deepens and the rate increases five to ten cycles per minute, but it is not accompanied by any oppression, — rather the reverse, in fact.

The capillary areas become injected, but this phenomenon is not so marked in the regions actually in contact with the heat as with the local treatment. The fact that the capillaries of the face, which is never subjected to the heat, share this general distention, even when constantly under the influence of the breeze from an electric fan, demonstrates the profundity of the reflex obtained.

The patient reeks with perspiration, the acidity of which is markedly increased over that normally exhibited.

The sensation is not disagreeable to the patient, but quite the reverse usually. A pleasant languor ensues after about ten minutes and lasts for an hour or two, and the patient usually becomes drowsy and sleeps. If the treatment is continued too long the languor gives place to exhaustion, with cardiac palpitation and oppressed breathing, which sometimes persist for hours.

By this profound stimulation of the deep trophic centers we secure a more rapid and complete oxidation of *effete* materials which are clogging metabolic processes, figuratively speaking, into normal excretory products, — urea for the kidneys, CO² for the lungs, etc., — which are then easily disposed of by the appropriate organs, and a rapid production of

more vigorous and healthier cell elements which are much better able than their predecessors to resist toxemia and microbic invasion. We not only obtain a corrective influence in nutritional disorders whose origin is in the deep sympathetic, but if the patient is suffering from an infectious invasion we increase vastly the resisting power of his phagocytes and tissue elements. The profuse perspiration carries out with it also a certain amount of any toxine that may be present, and thus assists in relieving the depression of nerve centers due to systemic toxemia.

The functional activity of every organ and tissue in the body is immediately augmented, but this exaltation of function is not followed by a reactionary debility. Patients frequently continue to improve generally, for months after a course of body hot air treatments.

It will be seen that the physiological action of hot air is in line with that of hydrotherapy, electricity, the Turkish bath and massage, but under some conditions is much more profound than any of them.

During the demonstration of the body hot air treatment which you are about to witness, you will be enabled to observe for yourselves the acceleration of the pulse rate and the modifications of the character of the impulse which have just been described, the rise in the body temperature, the profuse perspiration and the manifestation of deep reflex influence upon the sympathetic, as evidenced by flushing of the face, which will not be exposed to the heat.

In order to save time it may be as well to start the treatment now, and if you will approach the apparatus we will prepare the patient for the *séance*. As you will observe, he is wrapped in a Turkish toweling robe, boots made of the same material are drawn over his feet, several pillows are so placed under his body as to make his position comfortable while he is under treatment. We then place another thickness of ordinary Turkish toweling over that portion of his body which is to be exposed to the heat, and the preparation is complete. His pulse, you will notice, is 64 per minute and his mouth temperature 98.6° F.

The engineer informs me, I am sorry to say, that the total gas supply for this portion of the building comes through a half-inch pipe, hence we shall not be able to secure 350° of heat for this treatment. It is necessary to have at least a five-eighths inch supply pipe to secure this degree of heat in a body apparatus. We will do the best we can with what we have, however, and if the patient responds kindly it will be possible to demonstrate the phenomena susceptible of induction by the body application, even if the treatment intensity does not reach 350° F.

I had intended to have blood counts made upon the patient before and after treatment, in order to demonstrate the modifications produced, but Dr. Jeffries, who was to have rendered us this service, is unavoidably prevented from being present. I had also intended to have quantitative determinations made of the total urea output for the twenty-four hours preceding and again for a like period succeeding the treatment, but we have been obliged to substitute another patient for the one upon whom it was originally intended to demonstrate this treatment,

and through a misunderstanding a proper collection has not been made of this secretion, hence I shall have to ask you for the present to take my word for the fact that these modifications in blood and urine take place as I have stated.

In order that the degree of variation may be observed between the temperature of the air in the top of the apparatus, where the thermometer is ordinarily suspended, and that which actually comes in contact with the patient, I will suspend this second high-temperature thermometer through this ventilation aperture by means of this cord, at the level of the patient's body. We will now turn on the heat and leave the matter in charge of the assistant, while we finish our consideration of the subject, after which we will return and observe what modifications of the patient's physiological phenomena have been induced in the meanwhile.

I find the impression very prevalent among laymen, and to a large extent among physicians also, that dry hot air is lauded by its advocates as a panacea for all ills, to the exclusion of other remedial measures which have been demonstrated to be of value in diseased conditions. This impression is entirely erroneous, and the sooner it is removed the sooner will the thermotherapist be relieved from the undeserved opprobrium attaching to the false position in which it places him.

While it is unquestionably desirable to reduce our therapeutical armamentarium to its simplest form, yet it would not be desirable, wise or humane to withhold any useful agent from a suffering patient when the influence of that agent would prove beneficial to him. Valuable and numerous as have been the additions to our list of remedial agents during the past few years, yet we still frequently encounter cases which tax our resources to the utmost, and sometimes those in which our most strenuous efforts are inadequate for the securing of the patient's recovery. While the use of dry hot air renders the use of many of the older measures unnecessary, because under its application the indications for the employment of the older measures do not arise, yet when a rational indication exists for the administration of any other remedy it should by all means be heeded, and in many pathological conditions hot air *needs* to be supported by other measures in order that a satisfactory curative result may be obtained.

I have already stated the necessity of administering salicylic acid in rheumatism; in arthritis deformans it is usually necessary and always wise to combine dietary regulation, drug tonics and other methods of physical therapeutics with hot air; in pneumonia it would certainly be most illogical to withhold strychnia, nitro-glycerine, or any other adjunct, the administration of which was indicated; in local septic infection the knife should always be used when pus has formed or tissue is sloughing; in nephritis, he who would neglect dietary regulation and the administration of drugs, however well he may administer his hot air, will find that his clinical results will very frequently give him cause to wish for additional resources.

The key to the situation consists in bearing in mind that dry hot air is simply a rational therapeutical measure, exhibiting a known and constant physiological action, which gives us a rational basis upon which to consider its application to a given

case if the case in question presents a known pathology. It will, alone and unaided, cure some disease processes; others will require that additional therapeutical agents be combined with it; and in still others all the curative resources at our command will not suffice to effect the patient's recovery. It exhibits in a marked degree the capacity to increase greatly our power to overcome pathological conditions, and because of this and the profundity of its influence in many situations it is entitled to a prominent position in our armamentarium.

I will say just a word in reference to apparatus and technique. The local apparatus, to be effective, must be capable of producing a heat of at least 400° F. in twenty minutes, and of maintaining it steadily at that point as long as desired. The body apparatus should be capable of generating a heat of at least 350° F. in half an hour, and of maintaining it at that point indefinitely. The heat should equalize itself in all situations and localities inside the apparatus, so that the thermometer reading and the temperature of the air which actually comes in contact with the patient should not differ more than 10% of the thermometer reading. The simpler the construction of the machine the easier will be the attainment of this result.

The difference between proper and thorough technique and the reverse will very frequently constitute the difference between success and failure in clinical results, and in direct proportion to the prominence with which this fact is endowed in the mind of the prescriber of hot-air therapy will the benefit accruing to his patient be pronounced. Experience in the management of hot-air apparatus and a good knowledge of the clinical phenomena producible with it are very necessary. The current idea that it is a perfectly easy matter for any physician to secure a hot-air apparatus and treat his patient, without any special knowledge of the agent or of the technique involved in the management of it, with reference to different pathological conditions, is entirely erroneous and much to be deplored. When this unfortunate impression has been eliminated, which it is to be hoped will be in the near future, better results may be looked for from the general employment of the agent, and appreciation of its beneficent powers will succeed to the lack of confidence with which it is so frequently regarded at present. The bulk of its failures to accomplish results in the past have been due to a lack of proper knowledge of its clinical possibilities and physiological action, familiarity with which would have taught that the effects demanded should never have been expected of it, and because of inefficiency of the technique followed with reference to the individual case.

I wish to refer briefly to a popular criticism upon hot air, namely, that the curative results dependent upon its use are not *permanent*. This criticism is based upon the belief that hot air is only a palliative measure, like a dose of morphine in painful conditions, for instance, and would never be entertained if the profound influences upon physiological function, which we have been discussing, were taken into consideration. This belief was probably engendered by the observation that cases of rheumatism treated with hot air *alone* very frequently do "come back," but this merely means that the dis-

ease was not *cured* because the thermal agent was not properly supported, and neither hot air nor any other remedial agent can be expected to do alone what it will when combined with proper adjuncts. The advantages exhibited by hot air consist in its power to accomplish, either alone or in combination with other agents, that which it is impossible for any other combination of agents to accomplish without the aid of hot air.

Another fact bearing upon this criticism is that when we have carried a patient through an attack of pneumonia, typhoid, rheumatism or malaria, we cannot assure him that he will never have the disease again, no matter what curative agents we have employed. We can only be certain that this one attack has been extinguished. If appropriate environmental and constitutional conditions again obtain he will surely have to sustain another attack, no matter how perfect may have been his health in the meantime. When men no longer contend with conditions which engender habits of life that are inconsistent with their perfect physical health, then, and not till then, shall we be immune from repeated attacks of disease; and when that millennium has arrived hot air and every other remedial agent will have retired to the oblivion of complete *désuétude*.

In closing, I wish to refer briefly to another criticism which I have seen, namely, that local hot-air applications to localized infections of any sort were dangerous, and very likely to transform a local into a general pathological condition. I have never heard a logical defence of this statement, and I have never heard of an authentic case where there was any satisfactory evidence that such a result was properly attributable to hot air. Further, in the many thousands of such treatments which I have administered myself, and have had administered under my supervision to such cases, I have never, in a single instance, seen the slightest reason to consider that hot air had been guilty of precipitating such a disaster, and I am free to state my entire disbelief in the existence of any cause for apprehension in this respect.

We will now, if you please, return to the patient whom we left in the body hot-air apparatus, and observe what modifications, if any, have been induced in his physiological phenomena.

He has been under treatment thirty-five minutes, and the first thing that attracts our attention is the heavy perspiration and the marked dilatation of the capillary circulation of the face. When we left him at the beginning of the treatment his skin presented the dryness normal to that of a healthy man, now it is streaming with perspiration; before treatment his face was devoid of color except the slight rosy tint incident to a good circulation, now it exhibits a blush that would do credit to the modesty of a maiden of sixteen, should she find herself exposed to the gaze of so many representatives of the opposite sex in such a *déshabille* as invests the patient at this time. His pulse is 96 per minute as contrasted with 64 when the heat was turned on, and his body temperature, as registered by this thermometer which I have just removed from his mouth, is 100.6° F. as against 98.6° F. which you will remember was the previous reading.

We will now turn off the heat and allow the patient to cool, lying in the closed apparatus for ten min-

utes; then the car will be drawn out and the patient left to cool in the air of the room for twenty minutes more. His temperature will by this time have returned to the normal and his pulse nearly or quite so, and he will be given a sponge bath with soap and water, to be followed by an alcohol rub. After resting in the recumbent position for an hour he will be in condition to get up and go home, and if any of you meet him during the next twenty-four hours it will be instructive for you to ask him how he feels.

The thermometer which was suspended in the apparatus registers 325° F. as contrasted with 335° F., which is the registration of the thermometer which is in the normal position,—a discrepancy of 10° F., which is, of course, not large enough to make any material difference with the efficiency of the treatment, and demonstrates that the apparatus which we have been using is reliable and efficient.

If any one has any questions to ask, it will give me great pleasure to respond to his queries.

THE RÔLE OF ATMOSPHERIC PRESSURE
IN THE HIP JOINT.¹

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IN 1836 the experiments of the Brothers Weber went to show that air pressure played an important part in the mechanism of the hip joint; that when the joint was opened, the letting in of the air made it possible for the head of the femur and the acetabulum to separate; that on replacing the femur in its former position and covering the opening into the joint with the thumb, the then air-tight condition prevented the separation of the bones. Since this time most of the textbooks of anatomy, in successive editions, have made statements implying the truth of this, for example:

Cunningham, "Practical Anatomy," 1896, p. 252: "The cotyloid ligament fits closely upon the head of the femur, and, acting like a sucker, exercises an important influence in retaining it in place."

Gerrish, 1902, p. 243: "The cotyloid ligament, . . . aided by atmospheric pressure, holds it [the head of the femur] in place when its ligaments are divided."

Gray, 1901, p. 270: "The cotyloid ligament closely surrounds the head of the femur and assists in holding it in place, acting as a sort of valve."

Holden, "Osteology," 1887, p. 233: "When crusted with cartilage, the ball [of the femur's head] fits so accurately into its socket that it is retained by atmospheric pressure alone."

McLellan, "Regional Anatomy," 1892, p. 233: "The ligaments are considerably assisted by the atmospheric pressure, which is sufficient to hold the bones together after the severance of all the ligaments and of the overlying muscles."

Merkel-Henle, "Grundriss der Anatomie des Menschen," 1901, p. 132: "Lerade hier beim Huftgelenk ist der Luftdruck für die Integrität desselben von grosser Bedeutung."

Poirier et Charpy, "Traité d'Anatomie Humaine," 1899, vol. i, p. 728: "Evidement la pression atmosphérique intervient pour le maintien du contact entre

les surfaces articulaires, mais pas plus à la hanche qu'ailleurs."

Testut, "Traité d'Anatomie Humaine," 1899, vol. i, p. 576: "Parmis les causes qui maintenant les deux surfaces articulaires solidement appliquees l'une contre l'autre, la plus puissante est la pression atmosphérique."

Woolsey, "Applied Surgical Anatomy," 1902, p. 436: "The cotyloid ligament holds the head in place by atmospheric pressure, when the capsule and surrounding muscles are divided."

As it did not seem reasonable that the above statements could be true, the following experiments were made: Among sixty-four hips in the dissecting room there were found seven in which the bones fitted accurately together, and in which the muscles and ligaments had been sufficiently undissected not to interfere with careful data. The seven cadavers were suspended in the vertical position and three pins driven in, one into the anterior superior spine of the ilium, one into the iliac crest directly above the line of the thigh, and the third into the great trochanter of the femur. (Two points were taken on the ilium from which to measure, as it was thought that when the head of the bone fell out of the acetabulum it might do so in a direction parallel to the neck of the femur,—in which case the measurement from the anterior superior spine would be the most valuable; or it might do so directly downward,—in which case the measurement from the crest would be the most valuable.)

In the results, the average of these two measurements is given. In all seven cases, even after the suspension of the cadavers, the head of the femur was snugly in the socket, there being no appreciable separation of the bones, so that the conditions corresponded as closely to those in the living as is ever likely in the cadaver. Air was then let into the joint by trephining through the innominate bone from within the pelvis, and nicking the synovial membrane with scissors. In no case did careful measuring show the least separation of the bones. Therefore, whether air was or was not let into the joint made no difference in their relative positions.

If negative air pressure does not exist in the cadaver, it seems even less likely that it would be present in life, when the tonicity of the muscles and the elasticity of the ligaments are certain factors in maintaining the integrity of the joint.

To determine, then, what did hold the bones in contact, the muscles, capsular ligament and cotyloid ligament were successively cut, with the following result:

CADAVER.		1	2	3	4	5	6	7	Av.	Inc
Before interference	S.T.	12.50	10.31	13.75	12.81	10.62	13.50	12.25	12.49	
	C.T.	11.25	13.75	12.50	13.12	12.81	13.25	12.50		
After trephining into joint from within pelvis	S.T.	12.50	10.31	13.75	12.81	10.62	13.50	12.25	12.49	0
	C.T.	11.25	13.75	12.50	13.12	12.81	13.25	12.50		
After cutting all muscles between trunk and lower extremity . . .	S.T.	12.50	10.31	13.75	12.81	10.62	13.50	12.25	12.40	0
	C.T.	11.25	13.75	12.50	13.12	12.81	13.25	12.50		
After cutting posterior half of capsular ligament . . .	S.T.	12.81	11.25	13.75	12.81	10.62	14.00	12.25	12.72	.23
	C.T.	12.65	13.75	12.50	13.48	12.81		12.75		

¹ Read at the Boston Society Medical Sciences, January, 1903.