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### SKELETAL ALIGNMENT AND MUSCULAR BALANCE IN THEIR RELATION TO PAIN, FUNCTION AND DEFORMITIES.

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Grace of position, ease of movement, beauty of form, strength, virility, poise and bodily control are to the extreme degree dependent upon muscular balance and skeletal alignment; while deformity, weakness, tire, pain, lamed function and misery follow close upon the heels of unbalance, either of the muscle or of the skeleton. We speak of the muscles as flexors, extensors. etc.: of their abducting an eye, or contracting an orifice, but the one who sees nothing more in their action than this, misses the whole poetry of life; loses the entire beauty of motion. Muscular balance is not a condition simply of equal flexors and extensors, but is dependent upon the state which permits every alteration in the muscle tension to take place in perfect balance, in beautiful co-ordination, with no jerk, no pause, no lost motion, and is not the result simply of a pull of this muscle, a contraction of that. We desire to move the head forwards, for instance. From the anatomical works one would think the process was something like this desire from the brain. Attention scalmi. On guard sterno-mastoids. Now, all together. Muscle in front of neck contract! Steady! Hold!!, as if in parody of the German Hochheimer, we were "doll babies."

If the muscles acted as usually described, then the movement would be hesitant and jerky, like the automatic dolls, with a pull to do this and a pull to do that; and this may, and does, happen in diseased conditions, when the muscular balance is lost. Observe the difference in the natural movements. The desire to flex the head arises. Instantly the chin moves downward. There are no muscles thought of. Their position is not comprehended. No idea of the mechanics. The wheels of the machine are neither seen nor heard, but instantly as the head inclines forward, the shoulders move backwards, the loins arch, the hips flex, the knees extend, and the feet go into flexion. Every muscle from head to foot, from complexus to hallucius has changed its shape and altered its balance. Every joint has moved, and the skeletal alignment has been completely changed, yet the balance has been continuously preserved in absolute poise, in beautiful harmony and in

perfect time. So natural as a thing of life, every ounce, aye every grain that has been moved forward beyond the center, is exactly compensated by a corresponding ounce or grain moved backward, and the balance ever secured. A mechanical poem in health and youth.

This body of ours is poised on the narrow base of the feet, or on one foot after the other, when progression is being made, as an inverted pyramid, which is forced to change its gravity center, and has as its only security in space, this perfect muscular balance, and its only stability the alignment of the bony structure. Consider the ballet dancer how she spins and curvets. Consider her shape, her grace, her weight: pivoted on a narrow point how she leaps and bounds and curves in delightful harmony, in unstable equilibrium always yet in ample security in the safe protection of this muscular balance. Consider also the architect with the problem of balancing his pyramid on such an apex, and ask him how fast he can move his base, and what would be the effect of a simple leap or gambol on his structure? The maintenance of balance is the direct result of the exact co-ordination of the muscular system acting upon the bony frame. From the builder's and engineer's standpoint this frame should be rigid and unyielding, symmetrical in position and weight, decreasing in strength and solidity from below upwards, with the gravity centrally bestowed. Balance, security and strength are almost inconceivable without this.

Quite different, however, we find the human skeleton; loose in structure and perched on its smallest point. The base, such as it is, is composed of many small bones, bound together by flexible ligaments, like a handful of pebbles tied together by strings, and allowing some to wobble and some to slip in all directions. The stability of this base it is true is supplemented somewhat by being held in an elastic retaining cup, but this is all. This doddering base, supports on a hinge two uprights, which again support through an extreme hinge, another upright, increasing in strength and weight, contrary to the law, as it rises. This pillar then after having its upper end set off at an angle of about  $130^{\circ}$  is placed away at the side of the weight to be carried. The weight is then transmitted through the medium of a ball and socket universal joint. This sliding, hinged, wobbly, mal-aligned, unstable structure constitutes our base of support. Two such supports embrace our whole ground contact and the levers on which we stand and progress. It is true that this wobbly affair is to a certain extent restrained by strong ligaments but at the best the ligaments, capsules, etc., permit all the movement, all the insecurity, all the instability described, and more. The truss which carries the weight above, is also broken in the

middle and permits of motion in three directions, and this in three separate places, and to cap the absurdity, the weight falls upon this truss posteriorly to the center and through a curve. Again, remember the conditions do not permit of any braces, any supports applied to weak places. Muscles have no stability, no rigidity, can make no pressure but only supply security and strength by their assistances in maintaining balance and position by constant elastic pull and counterpull; by what is called "tone"; by the exact balance and co-ordination in every fibre; by instant controlled involuntary response to every change of posture; maintaining at all times, in every position, the best possible alignment, strength and control. Such exact balance is almost beyond thought and mechanically impracticable, when we consider the shifting of weights and the transmission of power in progression, even by a gyroscope.

Consider for a moment a muscle during its physiological action. Take the deltoid for an example of what I mean. It is a muscle with a single insertion, is supplied by a single nerve and must be-considered as a unit muscle, and yet the range of its power, the multiplicity of its action, the beauty of its control and effect, is marvelous. It is at the same time an abductor of the arm, is an inward and an outward rotator, it is active in pulling the arm backward, and also is an efficient aid to the pectoralis in drawing it forward. Some portions of the muscle are contracting, while others are relaxing, while at the same time other bundles of fibres are maintaining their tone. All the various actions are performed in unison in perfect balance, in complete harmony, yet we remember it receives its innervation from a single nerve. The man who thinks of this muscle as simply contracting to a proper stimulus and again relaxing, until once more stimulated, surely fails to appreciate most of its capacity, and loses all its beauty, balance and harmony. It is not to be presumed that because of this harmonious balance, the muscular bundles on each side of a bone, equal one another in strength, weight, or capacity, for usually this is not the case. So far as strength is concerned, flexors of a joint generally exceed the extensors, the inward rotators exceed the outward rotators, the adductors are much stronger than the abductors, and the back muscles are more powerful than the abdominal. Yet in spite of this apparent potential inequality, perfect balance maintains. Under what circumstances does this balance remain in harmony? Does the maintenance or even increase of the muscular inequality disturb the balance? No! The balance is apparently governed and maintained by the so-called muscular sense. By what we speak of as "tone" and so long as this remains normal the balance, poise and harmony are

always secure. It remains true during the lengthening of growth, after accidents causing the dividing of big muscles and in shortening due to loss of or an overlapping of bone. A moment since and it was said that inequality of opposite muscular grouping did not necessarily disturb the balance, nor prevent alignment, so long as the muscular tone remained, but this tone is at once lost, and this alignment promptly disturbed, if this inequality (be it ever so little), is due to paralysis. Then at once the stronger group masters the situation, steadily contracts and becomes shortened, loses its contractibility, and becomes contracted, while on the other hand, the weaker muscles stretch and stretch, become more and more pulled out and lengthened, lose at-length their contractibility also, get pale and weak in their fibres and the paralysis which began in the nerve lesion is increased by the overstretching and the "tonie" and balance could hardly be recovered unless the alignment is re-secured even if it were possible for the nerve lesion to be repaired.

May I again emphasize, so that my position may be firmly clinched in your memories, that the paralysis and loss of muscular balance increase as the direct result of the secondary over-stretching, which by the by is a fact to be remembered, when dealing with any form of paralysis and any kind of deformity consequent upon paralysis, especially of the antero-poliomyelitic type. This fact also is one of the things we are up against in the treatment of club feet, although we have here a stronger influence at work in preventing proper alignment, as will be seen later, when we speak further of skeletal alignment. You will then readily see that muscular balance being disturbed, loss of alignment must ensue, and contractions with the production of steadily increasing deformities result.

Looking at the matter from this standpoint it is at once evident what permanent advantages can be expected from tenotomies in joint deformities with contractures. When there is a temporary loss of muscular balance, with subsequent mal-alignment, due to pain, infection, or as the result of injury, with some contracture on the one side and over stretch paresis on the other, as we have spoken of, then tenotomies of the tendons of the shortened muscles, followed by re-alignment, reposition, and the mechanical holding of the proper position, over a period long enough for the over-stretched muscles to recover their tone, may, and usually does, give happy results; but when done, as it often is, in deformities due to Little's Disease, or more particularly in deformities from poliomyelitis paralysis, "it is to laugh." In such an operation no balance

is restored, or rather the balance is not an economic one. It is rather like the balance obtained by the man who, having \$80.00 in one bank and \$120 in the other, got an equal amount in each by taking \$40.00 from the \$120.00 and throwing it into the depths of the sea. A kind of balance to be sure, but hardly to be considered in the interest of economy or conservatism.

It is true that alignment can be secured and deformities corrected under such circumstances; but only at the risk of lost power and diminished control. Also, muscular balance not being secured, or more correctly having been wantonly wasted, proper alignment cannot be maintained except by mechanical appliances, which increase in weight and complexity, in proportion to the power which was foolishly destroyed. As a matter of fact in ordinary practice competent mechanical apparatus is not secured under such circumstances and deformity again, even increased deformity, is the end result. It is folly to seek to remove deformities due to loss of balance and alignment from paralysis, by cutting off most of the remaining power, yet such crude processes are daily practiced. We should, rather try to conserve power, alter its direction, change or reinforce it, but never destroy it. Earlier we spoke of yet a stronger influence at work in preventing proper alignment after long continued deformities, than the contracted muscles and the shortened ligaments, etc. I referred then to the effects of what is known as Wolf's law, and it appears proper at this time to consider it for a minute.

*Wolf's Law.* "Every change in the form and function of the bones, or of their function alone, is followed by certain definite changes in their internal architecture, and equally definite changes of their external configuration, in accordance with mathematical laws." That is, parts take on new shape and configuration, when functional strains are changed from the normal, and are again transformed to the normal, when the improper relation of strain and weight carrying have been removed. In fact he insists that the very shape of a bone is caused by the function it is called upon to perform. If the work required is different, then the shape will be different. Not only is the shape altered, but the internal structure is also altered, or as I am in the habit of putting it in teaching, the shape of a bone, as well as its internal architecture, is altered and arranged, entirely with relation to the way strain falls upon it, and the character of the work it is called upon to perform.

If all this is true and it is a law, and in my mind there can be no question of it, then it is therefore very evident that deformities are simply the result of bad static conditions - that

is, mal-alignment. Nothing favors and produces deformities like deformities. I shall be glad to have these facts, these laws, kept closely in mind for we shall refer to them later in an attempt to point our arguments.

Such remarks as the following are often made to me in this connection: 'What has all this to do with the practice of medicine? What has balance and alignment to do with the healing art? We hear what you say about deformities and perhaps admit this to some extent, but we are not instrument makers nor physical culture teachers. Our general patients are not particularly concerned with their shape, or at least do not come to us openly for it. What interest has all this for the practicing physician? I reply: Has surgery anything to do with fractures and injuries, or do you ever treat paralysis in any form? Are you ever consulted by people who are lamed? Anybody ever limp to your office, or does any portion of your work deal with people who use crutches or a cane? Does the relief of pain constitute any particular part of your work of practice? Do sufferers from rheumatism (which I believe in four instances out of five is not rheumatism at all), ever consult you? Then I say unto you that you are especially interested in the conditions spoken of, for no inconsiderable part of the suffering and distress and lameness of these ailments are purely mechanical and are relieved by mechanical aids. Many of them, that is the symptoms of which they complain, are due to a loss of muscular balance, or a lack of proper skeletal alignment. Do I hear you say, What has skeletal alignment and muscular balance to do with pain? What has strain to do with suffering? What has bad alignment in the structure of a building to do with stress, strain and weakness of that building? Try your engineer friends with these questions, and then think yourselves - why should weak feet and pronated ankles be connected with growing pains and rheumatic pains in the knees in children? Why should people with spinal osteo-arthritis have sciatica or any neuralgia? These are questions which come up and are daily asked of me, and the answer is simple. Take a young child for instance, who has feet which pronate at the ankles when the weight falls on them. Follow it for an instant and watch it under strain. The lower end of the tibia slips inward in relation to the foot which is fixed to the ground. The foot of course at once suffers in consequence of the side thrust, and the effect is readily noticed. But follow further; to maintain equilibrium, the knee moves inward, and a genu valgum is produced, which increases greatly the strain on the internal lateral ligament of the knee. This produces strain, irritation and congestion at the epiphyseal line at its most active functioning period. Tenderness and pain soon follow and "growing

pains" and rheumatic pains are soon heard of. This pain is oftentimes severe, when the angle at the knee is increased, from muscular spasm provoked by nature's effort to maintain efficiency, in spite of the bad mechanics.

Again, as the result of the epiphyseal congestion, and in response to Wolf's law, there is an overgrowth of the internal condyle, with permanent valgus knee deformity, and a lowering for the remainder of the individual's life of the mechanical efficiency of the legs. At a later period of life the same weak feet, the same bad alignment, the same mechanical sequence is the most common cause of villous arthritis - probably one of the most common of the diseases you are called upon to treat, by the by (also ordinarily called rheumatism), and which our lack of knowledge offers to our friends the osteopaths a most fruitful field of interest and perhaps the most productive part of their work, and incidentally, although of course of not much interest, loses us a most desirable part of our income. Even this is not all, for the changed angle at which the weight is borne at the hip alters the balance of the lumbar and intervertebral muscles; favors slip at the sacro-iliac joints and backache is a usual result.

Again, a common question is, Why do you think osteo-arthritis of the spine gives rise to sciaticas in cases when the absence of other symptoms offers satisfactory evidence that neither the nerve roots nor the plexus are affected? While not admitting that the so-called satisfactory evidence is at all conclusive of the freedom or involvement of the nerve roots, yet in most cases the alteration of the vertebral alignment offers sufficient cause for the neuralgia. When the hips also are the seat of bony changes, as is often the case, there is usually no question on the point, but where they are not, the vertebral locking is followed by an alignment sequence necessary to maintain equilibrium and secure functional mobility which is sufficient. When bony changes in the vertebra exist the mobility of the column is restricted and its curve is altered, and nature seeking the direction of lesser resistance and anxious to preserve function, compensates for the loss of mobility in the vertebrae, by an increase in motion in the sacro-iliac joints, or by a change in the inclination of the pelvis. As a matter of fact this change can often be easily demonstrated and the sacro-iliac slip detected. Of course when we remember the relation of the sacro-iliac joints to the component parts of the sciaticae it is readily understood why pain is a frequent result of the mal-alignment and twist of these joints, even when the pelvic branches of the plexus are found free. We need go no higher than this to find ample cause for the pain and a reason for the neuralgia.

In this connection I desire to assert that osteoarthritic changes in the vertebrae, may be the cause of anesthetics, hyperesthesias or paresthesias, produce atrophies, may inhibit or excite the sexual impulse, and in my opinion may even be the cause of paresis or paralysis, and that the presence of any of these symptoms cannot be conceded as positive evidence of a central or cord lesion, and as ruling out the question of an osteoarthritic etiology. I am moved to this statement, which I did not know was doubted, on account of its being recently affirmed by men in whom I have great confidence that the presence of some slight paresthesias in a particular case, proved a central lesion and was against osteitic changes, even in the presence of mechanical impediments, which effectually prohibited more than half the normal spinal motion.

A girl twelve years of age appears to-day from Bakersfield. She had poliomyelitic paralysis seven years ago, or when she was five years of age. She is on crutches and progresses after a fashion, carrying some little weight on the right leg. Let us consider this child for a minute or so, and if possible trace the sequence of events, which as the end result, is responsible for the terrible condition and deformity. Examine her. The left leg dangles in space, with a pendulous swing as she moves, the foot hanging about 20 cm. from the ground, and the leg can readily be put behind the head. Look at the skeletal deformities presented which in their development completely overshadow the paralysis, and in fact definitely increase the original paralysis and render futile any use of the muscular structures which remain. The hip is flexed almost to a right angle, adducted and rotated outwards, the adductors, from the combined effects of the poliomyelitis and the over-stretching, being flaccid as a piece of wet rag. The knee is flexed to nearly a right angle. The tibia is rotated outwards and partly dislocated backwards and outwards. The foot is hanging in an extreme position of equino varus. The only muscle evident in the whole extremity is the biceps and possibly a tiny amount of a thin tendo-Achilles. With this of course we have the capsules and ligaments, not to mention the vessels and nerves on one side of the ankle shortened, and on the other side lengthened. This added to the overgrowth of the internal condyle at the knee, and the changes in the bones of the foot, especially in the astragalus and scaphoid in the foot, in response to the changes in position and function, as we have before learned, could be expected according to what we know as Wolf's Law. The paralysis, the deformities, the changes in shape of the bones effectually prevent alignment by the ordinary means. The altered alignment in addition to the over-stretching also shuts out any use of those muscle bundles which still



may have innervation, and the picture is complete. A useless, dangling appendage, which is simply in the way, an incumbrance which is dragged around by the sufferer. The right leg is also out of alignment at the knee, with a valgus foot. All the muscles are very weak, but present, except the tibialis anticus and posticus which cannot be demonstrated. What can be done for her? Can anything be promised? We believe that proper skeletal alignment can with some difficulty and patience be restored, and probably a functioning position of the leg will soon, with the aid of some simple mechanical aid, allow her to walk after a style. Then later, the better circulation which comes with function, and possibly some restoration of muscular action which will come when the overstretched fibres are given a chance, will probably allow the girl to get around fairly comfortably without crutches. (As a matter of fact, since this paper was begun, this alignment has been made, and some little changes in the insertion of the muscles added, and the girl is now able to walk blocks, alone and without crutches.) You will understand that in this report I am not intending to argue that restoration of skeletal alignment is all that is necessary to re-establish normal function in deformation consequent upon infantile paralysis, for that as you know would be ridiculous, but I am saying, and am intending to say, that the restoration of alignment is a sine qua non to the recovery of muscular balance, and mechanical efficiency, and besides this is the most important step in the first aid to the crippled that we are conversant with at this time.

A few weeks ago there was a man referred to us, 36 years of age, who was convalescent from pulmonary tuberculosis. He, however, had developed a rigid spinal deformity, progressive in type, the so-called "spondylose rhizomelique of Marie." The whole column from the first cervical vertebra to the tip of the coccyx formed one long posterior curve, which increased in curvature from below upwards, and was so rigid that any twist or turn or bend was impossible. The body was so far out of alignment that in order to maintain the biped position it was necessary to keep both hips and knees in flexion, and during the last few weeks a cane was necessary to secure postural balance. Consider for a moment the prospect of the future of this man. Doomed to either a crouched, sitting or a bedridden side position for the rest of his life. Under such circumstances and maintaining such a posture we might naturally also expect a return of the pulmonary tuberculosis, and a somewhat radical procedure was advised and accepted. Under anesthesia we manipulated his spine and loosened its extension and flexion until the restoration of his spinal curves was possible. The position was of course secured by a cast and rest is still

maintained. No untoward symptoms occurred and we expect that in a short time the man will be around with a comparatively easy carriage in an erect posture.

Of course the instances I have detailed are those of extremes, intentionally selected, in order that the character of the principles shall be strongly asserted, but the truths are just as definite although not perhaps as evident on a chance glance in rheumatism, in sprains or any of the ordinary affections which tend to lameness and crippling. Let me call to your attention a few of the simple cases which occur in daily practice. All remember the stiffening of the knee which follows so frequently a fractured femur, even when the fracture is in the upper third, so that it cannot be due to callus invading the joint. Neither on the other hand, is the fixing due to the immobilization from your splint, for, take it from me, that rest does not promote ankylosis in joints whether secured or maintained, for repair in injuries or for recovery from diseases.

Take a schoolboy, of an irritable, inattentive type, who tires easily, has violent headaches, is erratic and flighty and perhaps has vomiting spells. What is the cause? My oculist friends tell me this group of symptoms is often due to unequal muscular balance, and is cured by proper fitting glasses. Take the same case with some astigmatism added, necessitating a head tilt, disturbing skeletal muscular balance, and now if a close examination is made you will notice the lack of alignment of the vertebrae and perhaps some rotation, and a scoliosis has begun. Take the growing girl, a rapidly growing girl just before maturity with pronated feet, which you at once note. Pain in the feet? you ask. She replies to your inquiry, "No! I have no pain nor trouble in my feet," but she admits pain in her legs, in the back of her legs she tells, and in the knees too, perhaps at night when she tries to go to sleep, possibly also in the back. She easily gets run down and out of sorts and has to quit school now and then for a week or two. These growing pains annoy her quite a good deal. God save the mark! Growing pains! Growing idiocy! Utter and incontestable nonsense!! Pain means decay and death, and has nothing to do with youth and growth, life, energy and development. What then? What is the matter? Examine her again, and ten to one you will find that besides the sagging feet she is knock-kneed, her tibiae are perhaps curved, her back has sagged, her shoulders are hanging forwards, and she is lucky if a scoliotic torsion has not also begun. Poor child, no wonder she has pain and is tired. Her whole skeleton is out of alignment, her balance is interfered with, her stress and strain increased and the whole organism suffers. The

growing pains forsooth are nature's cry for relief from the strain and distress of mechanical inefficiency.

Allow me also to detail for your consideration a case which is repeated many times a year in my practice. A football player during the press of the struggle injures his knee and is carried, or limps, from the field. The knee is shortly found swollen, tender, fixed and has a little lateral motion. The internal lateral ligament is torn, perhaps there is also a rent in the capsule, or even perhaps a rupture of a crucial ligament has occurred. The cavity of the knee is soon filled with fluid, blood perhaps or a serous fluid. This is the damage. Consider the minor degrees only. Such a pathology could not be reasonably expected to undergo repair in less than a month or six weeks, and the indications of mechanical treatment would be to secure extension as soon as possible, to maintain rest in all its phases at first, and later (three to four weeks say) to give a little movement, but at all times to consistently prevent abduction at the knee, that is to maintain rest, balance and alignment, especially alignment during the whole process of repair. What was done? What is usually done for such cases? He is put on a measly, narrow, posterior splint which made a pretense of immobilizing, and lead and opium compress applied. So far, not ideal, but fairly satisfactory, but within ten days he was walking or limping around on the leg without any attempt or advice regarding skeletal alignment. Look at the position of the limb during use. You have often seen such cases. Consider for a moment; knee slightly flexed, the thigh slightly rotated outwards, the leg more so, the foot turned almost straight out and pronated, throwing all the stress on the inner side of the knee and the man has a torn internal lateral ligament; allowing the tibia to slip backwards and outwards and there is probably a torn crucial ligament. Is it any wonder that after a lengthy convalescence the man is prone to other similar attacks and eventually has a "pretty bum" knee to carry through life? How many such instances have each of you seen? Let your skill be ever so much, let your technic be perfect, yet your surgical sense cannot be considered keen unless this matter of alignment, balance, stress and strain be always in mind.

You remember also the pains in the feet, legs and knees when your patient first gets up after typhoid, acute rheumatism or any weakening illness, all due to the same thing, loss of muscular tone, and all remedied by maintaining the proper alignment. You will notice that I am not discussing particularly the pathology of the conditions used as examples, for the limits of this address do not permit. I am only considering, regardless as it were of

pathology and etiology, the crippling, lameness and deformity of skeletal mal-alignment, and unequal balance, with the approach as it were towards use and function, when a functioning position is maintained. Yet greater and more lasting effects even than before suggested are often obtained, for nothing in my opinion will increase muscular balance, strength and efficiency like unto use and exercise and this cannot be done when the alignment is badly out. Nothing increases the function of a part, and nothing so favors repair, and a return towards the normal, as the use of the part in as nearly a natural position and condition as possible. Who that has ever seen the weakened, stiffened muscles, the knock-kneed, sagged-footed rigid-gaited, amble of a convalescent typhoid patient, and compared it with the slick, elastic-muscled gait and the erect, easy carriage of the same individual after a few weeks' exercise in mountain climbing, can doubt the truths of the statement that use in a proper functioning position favors function, repair, virility and energy, and promotes muscular balance and skeletal alignment, health, wealth and happiness?

Source: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1893610/pdf/calstatejmed00151-0034.pdf>