The value of extension in the treatment of fractures of the femur / by John T. Hodgen.

THE VALUE

OF

EXTENSION

IN THE

TREATMENT OF FRACTURES

OF

THE FEMUR.

BY

JOHN T. HODGEN, M. D.,

PROFESSOR OF SURGICAL ANATOMY, FRACTURES AND DISLOCATIONS IN THE ST. LOUIS MEDICAL COLLEGE.

[*Reprinted from the St. Louis Medical and Surgical Journal, April, 1878.*]

ST. LOUIS.
1878.

The Value of Extension in the Treatment of Fractures of the Femur.

Proposition 1st.—Continuous and equable extension is indispensable to the best results in the treatment of fracture of the femur.

Prop. 2nd.—Continuous and equable extension cannot be secured by lateral supports; the long splint of Liston or its modifications; nor by plaster of Paris dressings.

Prop. 3rd.—Continuous and equable extension can only be secured by suspending the limb.

Frop. 4th.—Suspension furnishes the best means for allowing motion to other parts of the body while maintaining constantly perfect apposition of the fragments of the fractured thigh.

The direction and extent of the displacement of fragments in fractures depend upon the violence causing fracture; the direction of the line of fracture, and the action of the muscles connected either directly or indirectly with the fragments of the broken bone.

The reduction of displaced fragments in all unimpacted fractures may be resisted or prevented by periosteum, ligaments, tendons, fascia, and muscles.

Maintenance will be interfered with by muscular contractions only.

The difficulty of overcoming muscular resistance in the reduction of displaced fragments in fractures, is determined by the force of muscular contraction, modified by the site of attachment and the direction of the muscular action.

Active muscular contractions are determined by stimulation of muscular tissue, applied directly or indirectly to the muscles. Muscles contract independently of stimulation. The contraction occurring without stimulation differs from that which follows stimulation, in this, that it is less in force and indefinite in duration, while the contraction responsive to irritation is violent (active) with greater force and of limited duration.

The tonic muscular contraction is that which, without equal resistance, causes and maintains shortening in bones obliquely fractured, and angling in transverse fractures which are not displaced.

When tendons are divided, the divided ends separate and remain so until they are united by new material. When muscles are divided the wound gapes and remains open from the tonic

---

* Extracted from the American Medical Associaiton Transactions, 1877.

contraction of the muscular tissue. If a limb is flexed for a week or two, it is found that the muscles which are permitted by the position to shorten are not easily extended to their normal length.

When an attempt is made to adjust the displaced fragments in a fracture, we have not only the force of muscular tonicity to overcome, but also the active contraction excited by the manipulation. But when the adjustment is perfect, the muscular tonicity alone tends to displace the fragments. Practically, a fracture is transverse when the line of fracture is such that the fragments may be made to abut one against the other in such a way as to resist the tonic contraction of the muscles.

The resistance to shortening thus afforded by the fragments thus appears immediately after the reduction of a fracture has led to the false conclusion that lateral supports are all that may be required in the treatment of transverse fractures.

I had recently, in our city hospital, a case of oblique fracture of the tibia, in which the line was so serrated that when the fragments were adjusted the length of the limb was perfectly maintained. Lateral supports were applied, and two weeks later the limb was found shortened, and the sharp angle of the upper fragment was found pressing against the skin of the shin. Now during these two weeks the ends of the bones had so altered that the serrations that at first fitted one into the other were absorbed, and the bones no longer possessed the irregularities that enabled them to abut one against the other. In the processes that precede the union of fractures, the bones become softened and absorbed to such a degree that the tonic contraction of the muscles which constantly press the one fragment against the other, will necessarily produce shortening. In every case then in which the tonic contraction is not resisted by some constantly acting force, shortening does occur.

The extent to which the ends of bones soften in the processes necessary to union is very variable, and depends on the degree and the duration of the increased vascularity of the fragments.

During the fall of 1874, A. W., aged 14 years, was brought to my office having both bones of the forearm broken. The fracture was a simple, transverse one, the ends were not displaced, but only formed an angle one with the other, the angle presenting toward the dorsal surface of the forearm.

The angle was corrected, and the bones seemed and were in perfect apposition. I applied the usual dorsal and palmar splints. The case progressed well for three weeks, and then the patient complained of pain on the radial side at the site of fracture, and the ulnar side of the fracture was more prominent. I then supposed that this prominence was due to an unusual deposit of provisional callus.

I readjusted the splints; a few days later there was a distinct angling, and the angle did not present toward the dorsal but to

ward the ulnar side. I tried faithfully to prevent deformity, but utterly failed. The radial side presented its normal appearance, but the ulnar angling was marked.

May 31, 1877.—I find to-day the angle of the ulna apparent, the radius straight. The lower end of the ulna is more prominent on the dorsum than that of the other arm.

The explanation that I propose for this, is that the shortening was greater in the radius, consequently the ulna was made to angle to conform in length to the shortened radius. This occurred notwithstanding the most carefully applied lateral supports, aided by the ulna and the inter-osseous membrane.

In Colle's fracture it is the rarest thing to have the bone unite without deformity. This deformity is especially well marked in the prominence of the lower end of the ulna, and this is no doubt due to the partial displacement of the carpal end of the ulna, consequent upon the shortening of the radius at the site of fracture.

Except in those rare and perhaps doubtful cases in which it is said fractured bones heal by immediate union, there is always an appreciable amount of new material joining the original matter at the site of fracture.

This new material is cicatricial (*i. e.*, imperfect), and will be replaced by more perfect bone at a later period.

It is common to speak of scars as contracting, and they do contract in the soft parts, and I know no reason why bone scars should not also contract.

The fact that fractured bones, recently united by provisional callus, are often found of the original length, and subsequently without angular deformity are found to have shortened, is conclusive evidence that the scars of bone are not an exception to the rule of contraction in cicatrices.

Is it possible that lateral supports can prevent the tonic contractions of muscle? I am free to say that I have good reason to know that lateral supports do not prevent the tonic contraction of muscles.

It is true that in clonic contraction muscles change their form without variation in volume, for when they diminish in length they increase in thickness, but muscles are largely made up of water and surrounded with connective tissue whose spaces are filled with fluid. It is absurd to suppose that muscles cannot and do not contract, when surrounded by lateral supports, as in the treatment of fractures of the thigh.

The serum surrounding the muscles, the serum in the muscle, the blood in the blood vessels, furnish a material so readily displaced that the muscles of the thigh could contract though the limb were surrounded by a case of iron fitting as accurately as the skin itself.

It is the practice after amputation of the limbs to apply a bandage snugly from the end of the stump up to the next joint

above, with the intention of preventing retraction of the flaps and consequent protrusion of the bones. After a day or two, I have invariably found the flaps retracted, and the bones failed to protrude in those cases only in which the flaps were left so long that the usual retraction was not sufficient to draw the soft parts entirely beyond their ends.

It will be remarked that surgeons in making amputations, with the probable retraction of flaps in view, make the flaps longer or shorter as the point of amputation varies from the point of origin of the muscles, which form a part of the flap. With the hope of giving more uniform support to the flaps, I have, many times, applied plaster of Paris bandages to the stumps, embracing them up to the next joint; but I have invariably found after a day or two that the flaps were retracted within the plaster casing.

In oblique fractures of the tibia, surgeons have in many cases found it impossible to prevent the rising end of a fragment from pressing dangerously on the skin of the shin, and the rising of the end is only one method of expressing muscular contraction, for the end is forced to rise by the lapping of the obliquely fractured bone at the site of fracture.

I have been thus tedious in multiplying facts in regard to muscular contraction, not because there is a question concerning the contraction of muscles after fractures, but for the reason that some prominent members of the profession have given utterance to language which has been misunderstood, which has been supposed to express the thought that every fracture of the thigh could be so treated by plaster of Paris dressing as to prevent shortening.

Let us for a moment consider the changes occurring in a fractured limb during the use of the long splint of Liston. Place the splint on the outer aspect of the limb, let it extend below the foot and above the hip, bind the limb and splint with the usual roller bandage, extend the muscles by such force as may be required to give the limb its proper length and allow the fragments to occupy their proper relations; now draw tight your well-padded perineal band and fix it so that it cannot loosen. You visit your patient on the second day to examine the dressings and find the perineal band is not tight, measure the limb and you find it shortened. Again extend the muscles, once more tighten the perineal band, and repeat this process every day or two for four, six, eight, or twelve weeks, and at the end of this time it will be found that the perineal band has elongated, the tissues about the perineum, the prominence of the rounded thigh, the fulness of the outer part of the leg, the plumpness of the instep having atrophied, and through these changes, both in the extending apparatus and the tissues, the muscles have by their tonic contractile power shortened the limb.

Follow another case: Put your patient on a firm table, place

a padded iron standard between his thighs, attach a screw-extending apparatus to the lower part of his leg, etherize the patient, then stretch the muscles until the ends of the fragments come fully into position, pad the projecting bony points with cotton wool, apply a wet bandage, impregnated with plaster of Paris, in layers sufficiently numerous to form a firm plaster case which accurately fits the limb and extends to the tuberosity of the ischium, the spine of the ilium and embraces the pelvis. Continue the anæsthetic and the extension until the plaster is firmly set.

Now do not fancy that because you have made the adjustment perfect and applied the plaster smoothly that this plaster will continue to fit perfectly. Atrophy will occur rapidly and unequally—the muscular tissue will constantly tend to produce the shortening, which the atrophy of the points of pressure of the extending and counter-extending forces will permit. After a week you will find you can put your finger between the foot and the plaster case, while you may place your hand between the plaster and the hip. If you percuss the front of the plaster case it will yield a resonant sound. It will be found that the limb is too small for the apparatus of fixation, and indeed the limb is not fixed, but badly requires fixing.

What now? Cut the case in front from end to end, take out a piece or put in padding, and once more adjust the fixed apparatus to the unstable limb. What can be more unstable than the ever-wasting, ever-changing tissue of the human body. The very blood which bears to the tissues fresh supplies of nutritive material carries back the products of disintegrated tissue.

The fact that it is found necessary after a few days to cut the plaster and readjust it is an admission that it does not make uniform extension. The time for readjustment is not reached until the shrinkage of the limb has allowed shortening within the plaster case. So soon as atrophy begins, and it does begin at the moment the extending agent makes pressure on the point of contact at the upper and lower parts of the limb, the muscles by their tonic contraction will cause the pointed fragments of an obliquely fractured bone to override.

We are told that this shrinkage must not be allowed to occur, that to prevent this the patient must get up and move about the room. In a report on fractures, read before the Surgical section of this Association in 1874, by Prof. Sayre, at Detroit, I find this language: "It will be particularly observed in studying these tables that the three cases of greatest shortening in which the permanent dressing of plaster of Paris was applied, were the three cases that were necessarily confined to their bed on account of other complications, showing that if this dressing is the one preferred by the surgeon, it is better to keep his patient up and walking about occasionally, as the limb will then fill with blood and retain its accuracy of fit to the plaster casing, whereas

the horizontal posture allows of more shrinkage, and the extension not being accurately retained necessitates the more frequent change of the dressings."

I can understand that the erect posture would allow an increased quantity of blood to flow into a pendant limb, and that the returning flow would be retarded, and that the plaster case would now be filled and kept full by the œdematous limb, but I cannot understand how the tissues at the points at which extension and counter-extension are made and kept so tightly filled with blood and serum as to make adequate extension on the limb. We may be told that the weight of the limb is to act as the extending force, and I am ready to admit that this would be sufficient, yet it is impossible to keep the patient erect during the entire six, eight or twelve weeks required for the accomplishment of firm union. If the patient be kept walking about the room for six hours in the twenty-four, it is quite as much as the most vigorous man could accomplish with a fractured thigh. The change of posture twice in twenty-four hours will imply the application of extension six hours, and its entire absence eighteen hours of the twenty-four.

The proposition is too absurd to deserve serious consideration. I do not wish to be understood as regarding lateral supports as valueless, but I do assert that lateral supports are of value in the treatment of fractures only so far as they aid in preventing angular deformity, and in transverse fractures aid as extending agents only by keeping the ends of the fractured bones opposite each other, and thus enable the bones themselves to resist the contraction of the muicles.

Having thus far considered the inefficiency of lateral supports only as used alone in the treatment of fractures of the thigh, and the impossibility of maintaining continuous extension by any of the so-called fixed apparatuses, I come now to consider directly the value of continuous extension in the treatment of fractures of the femur. By continuous extension I mean the employment of a force that does not vary in power.

To have continuous extension we must use a force that is unvarying, and apply that force so that it may not be modified by friction.

Elastic extension cannot be unvarying from the very character of the material used.

The weight and pulley as used by Hildanus and modified by Buck must vary in its action because of friction. Oblique suspension is the only possible way in which unvarying extension can be applied, and this is absolutely unvarying, provided the angle is constantly maintained and the weight of the suspended limb does not change.

The muscles that tend to produce a shortening in oblique fractures of the thigh, during the period of union of the fractures, when the ends of the bones are softened by nutritive

changes preparatory to union, are the muscles that tend to cause angling in transverse fractures after adjustment, either in one direction or another, and are so balanced by their relative strength and sites of attachment, that one and only one position can be found in which the opposing muscles will act with equal force upon the fractured fragments. This is due to the fact that muscles in extreme extension are capable of acting with more force than when in any degree shortened. The force of action decreases as the muscle is shortened to its limit when its power of contraction is nothing (zero). Hence it occurs that when the lower extremity, after fracture of the thigh, is placed on a line with the trunk (*i. e.*, in the straight position) the muscles that flex the thigh and flex the leg are relatively more extended (tense) than the muscles which extend the thigh and the leg.

Since some of the muscles of the thigh, *i. e.*, the gracilis, semimembranosus, and semitendinosus are adductors of the thigh as well as flexors of the leg, the extended position of the leg elongates these adductors, but when the leg is flexed they are comparatively short.

In the extended position of the leg and thigh, then, the flexors and adductors of the thigh would act with more force on the lower fragment than the extensors and abductors. On the contrary, if the leg and thigh are in positions of extreme flexion, the extensor muscles would act with more force than the flexors.

Please allow a quotation from Nathan Smith, from *Memoirs* by Dr. N. R. Smith, page 133: "If surgeons who are in the habit of applying bandages tightly around fractured limbs would take the trouble to investigate the subject, I think they would perceive that such practice can do nothing but mischief. . . . In a case of compound fracture in which the ends of the bones are in sight, or in which they can be touched by the fingers, if the surgeons will take hold of the limb below the fracture, while he keeps his finger on the fractured ends of the bones, he will find that by moving the limb into its proper relative situation with the limb above the fracture, the bones will readily come into apposition; but, if he attempts to bring them into apposition by pressing them down with his fingers, he will find it utterly impossible to do it with any force, unless he moves the limb below the fracture with the other hand."

John Aitkin, of Edinburgh, in 1771, says, in reference to maintaining extension: "The grand desideratum is, by some means or other, to create a temporary substitution to the now deficient apposition, which was afforded by the bone to the contractility of the femoral muscles."

Pott fully appreciates the importance, the physiological relation of muscles in the treatment of fractures, and John Bell approved the same course in reference to position.

The precise position in which the thigh and leg should be placed in any fracture of the femur, can only be determined by

the direction, site of attachment, and strength of the muscles acting on the broken bone, and the site and direction of the fracture; but in any case, a state of flexion of both leg and thigh, varied in degree, as determined by the site of fracture, will be found the best means of bringing the opposing muscles into that equal state of tension which will most certainly secure coaptation, and render fixation most easy of accomplishment and most comfortably borne.

In the reduction of dislocated joints, all surgeons recognize the importance of considering the force and direction of muscular action. If contracted muscles are to be elongated in the reduction of dislocations, we use moderate continuous extension, in preference to great force momentarily applied. The same rule should be observed in replacing the fragments in fractures.

After adjusting the fragments they are best maintained in position by such extension as will precisely substitute the extending force exercised by the bone itself before fracture.

I desire, now, to call attention to the uniform and persistent action of the force of gravity, and wish to say that the only possible way in which we can fully utilize the force of gravity is without the intervention of such apparatus as will afford friction. The methods by weight and pulley are objectionable, because of the unequal tension of the muscles due to the straight position, the friction incident to the use of a pulley, and the friction between the limb and the fixed bed on which the limb rests, and the impossibility of moving the body without either varying the extending force or disturbing the fragments by lateral deviations. If, however, the limb be suspended so that it, with all its coverings, floats freely in the air, we may, by removing the points of suspension from the perpendicular, get any amount of extending force required to balance the tonic contraction of the muscles.

The amount of force requred to maintain extension can be determined with accuracy, by varying the obliquity of the suspending cord until the patient is entirely free from pain, and this will occur as soon as the muscular force is so overcome as to allow the bony fragments to gain their normal relations. In practice I have had little difficulty in adjusting the extending force so as to make the patient entirely comfortable.

I do not wish to imply that the smarting pain of a compound fracture is relieved by extension, but only that the pain due to the disturbance of the soft parts by the irritation of the bony fragments no longer continues, and the pain of the contracted muscles is at an end.

Within twenty-fours hours, a child of five years will learn the precise amount of extension required for his comfort, and he will maintain that degree of extension. Fortunately, the condition of the most accurate adjustment is that of the greatest comfort to the patient.

With this suspension and extension, the surgeon may rely on the aid of his patient to maintain the adjustment. It will be found, as the case progresses, that much less extending force is required than in the beginning, and in practice it is observed that the patient wlll adapt his position, with wonderful precision, to the lessening tonic contractile power of the muscles. That,

Proposition first—In the treatment of fractures of the femur, continuous and equable extension is indispensable to the best resnlts, is conclusively shown in the impossibility of maintaining, with equal certainty, accurate coaptation by any other means.

Propositiou second—Continuous and equable extension cannot be secured by lateral supports, the long splint of Liston, or its modifications, nor by plaster-of-Paris dressings, because the material used in making extension yields, and the points of the body on which extension and counter-extension are made undergo atrophy.

Proposition third—Continuous and equable extension can only be secured by suspending the limb, because in no other way can we avoid friction between the extending force and the part to be extended.

Proposition fourth—Suspension furnishes the best means for allowing motion of other parts of the body, while perfect apposition of the fragments of the fractured thigh is constantly maintained, because there is no resistance offered to the movements of the limb in any direction in which the body may be moved, except in the direction from the point of suspension. In every other direction the limb follows the movement of the body without the least friction.

THE ST. LOUIS

Medical and Surgical Journal.

ESTABLISHED IN 1843.---PUBLISHED MONTHLY.

THOS. F. RUMBOLD, M. D., Editor and Proprietor; HIRAM CHRISTOPHER, M. D., Associate Editor.

Each Nnmber will Contain 80 Pages, Making a Volume of Nearly 1,000 Pages.

THE ST. LOUIS MEDICAL AND SURGICAL JOURNAL commences its *Thirty-Fourth Volume* with an increase of 24 PAGES. As it is now printed in smaller type, the increase in its pages nearly *doubles its former contents*. This has had the effect of greatly increasing its popularity and, as a consequence, its circulation.

THE JOURNAL will be conducted in the interests of the profession, and we look to it for that encouragement and assistance so necessary to success, and to the advancement of the Science and Art of Medicine and Surgery.

Although it is the *Pioneer of the Medical Journals of the West*, yet its present enlargement gives good proof that it is not too old, nor too set in its way to keep pace with the progress of the age.

THE JOURNAL WILL CONTAIN:

1, Original Contributions. **2,** Translations from the German, French and Spanish. **3,** Reports of Medical Societies. **4,** Clinical Reports from Private Practice. **5,** Clinical Reports from Hospital Practice. **6,** Selections from Current Medical and Scientific Literature. **7,** Editorials. **8,** Obituary Notices of Prominent Men. **9,** Reviews of Medical and Scientific Books. **10,** Notices of Books and Pamphlets Received. **11,** News Items. **12,** Meteorological Observations taken in St. Louis. **13,** Mortality Report of the City of St. Louis. **14,** Comparative Mortality Rates of the ten largest cities in the United States.

The Translations from the German, French and Spanish Medical and Scientific Journals, will be from those articles which contain the *advance* views of the Medical and Scientific men living in those countries.

THE JOURNAL will contain a full Report of the Proceedings of the St. Louis Medical Society, and a Summary of all the Societies in Missouri, and of many in Illinois and other States, thus placing before its readers the latest views and experiences of the profession in all the Departments of Medicine, Practical as well as Theoretical.

It will be the aim of the Editors, in all respects, to maintain the high and honorable position it has so long held. No personalities shall ever soil its pages; when discussions cannot be carried on without these, space in its columns will be declined.

Contributions of Original Articles on both Medical and Scientific subjects are invited from all parts of the country.

Articles on the following subjects will appear in the present volume:

Contributions on Fractures. By JOHN T. HODGEN, M. D., Professor of Surgical Anatomy, Fractures and Dislocations in St. Louis Medical College.

Contributions on Syphilis. By THOS. KENNARD, M. D., of St. Louis.

Contributions on Lithotomy. By DAVID PRINCE, M. D., of Jacksonville, Ill.

Contributions on Genito-Urethral and Rectal Surgery. By W. HUTSON FORD, M. D., of St. Louis.

Contributions on the Present State of Pathology of Phthisis Pulmonalis. A Series of Papers by J. HILGARD TYNDALE, M. D., of New York City.

Contributions on Genesis. A Series of Papers. By the Associate Editor.

Contributions on Urinary and Renal Diseases. By JOHN BRYSON, M. D., of St. Louis.

Contributions on Medical Experts as Witnesses. By FRED. T. LEDERGERBER, ESQ., of St. Louis.

Contributions on Nasal, Pharyngeal, Aural, Laryngeal and Bronchial Diseases, By the Editor.

From the above it will be seen that it is not the intention of the editors to confine THE JOURNAL to subjects relating to Medicine and Surgery alone; subjects collateral to these will receive attention, and such are invited from the profession. The departments of science are so closely connected as to make it almost impossible for a Physician or Surgeon to be proficient as such, without considerable knowledge of kindred branches.

Communications and all Subscriptions should be addressed to THE EDITOR, 1225 Washington Avenue, St. Louis, Mo.

TERMS:—Three Dollars a year, payable in Advance. Single Numbers Thirty Cents. Postage prepaid in all cases.