

The Classic

On the Means of Lengthening, in the Lower Limbs, the Muscles and Tissues Which are Shortened Through Deformity

Alessandro Codivilla

Published online: 27 September 2008

© The Association of Bone and Joint Surgeons 2008

The Classic Article is ©1905 by the Journal of Bone and Joint Surgery, Inc. and is reprinted with permission from Codivilla A. On the means of lengthening, in the lower limbs, the muscles and tissues which are shortened through deformity. *J Bone Joint Surg Am.* 1905;s2-2:353–369.

Presented by title at the Eighteenth Annual Meeting of the Association, at Atlantic City, N. J., June 8–10, 1904.

Richard A. Brand MD ✉
Clinical Orthopaedics and Related Research,
1600 Spruce Street, Philadelphia, PA 19103, USA
e-mail: dick.brand@clinorthop.org

The difficulties to be encountered in lengthening a shortened limb, are found, in operation, to be greater as regards the fleshy parts, than as regards the bones. It is comparatively easy to remove the splinters of a fractured bone which is wrongly consolidated; to separate a curved bone; or to perform an oblique osteotomy, but a decided limit is arrived at in the correction of a displacement, or in the lengthening of the bones, by reason of the contraction, or resistance, of the muscles. Our supreme consideration must therefore be given in striving to overcome this resistance on the part of the muscles, without however damaging in any way the action of the tissues. This is the special subject on which I desire to enlarge, as it appears to me that this important part in the cure of deformity of the limbs, has never been sufficiently taken into consideration.

As things stand at present, we trust to empiric measures to overcome this contraction of the muscles, whereas in reality mathematical precision should be used, in each special case.

But for this mathematical precision, we are still in want of a scientific basis. We are in fact, without the requisite knowledge as to how the normal muscles and other tissues act, when subjected to forced distention; as to how great an extent they are capable of being lengthened, without their

physiologic action being altered; as to the method, in lengthening, which may be best adapted to them; as to the action, while subjected to distention of those tissues which have become shortened through the separation of the bone which kept them in place; as to their loss in elasticity, when time has elapsed since their shortening, and as to many other questions, which I omit, for the sake of brevity.

In consulting works on the subject, we find that surgeons have adopted very diverse courses in cases of lengthening the fleshy parts, where there is shortening of the limbs. The greater number have applied constant traction, after having separated the bone; others have used great stretching, under narcotics, followed by constant extension of the muscles, by means of weights; others again, after the stretching, have applied the plaster apparatus. A very notable difference exists also as regards the degree of force which has been applied with the weights, ranging from a small, to a high number of kilogrammes, without a proportionate difference existing in the condition of the resistance of the muscles, in relative cases.

The treatment by the surgeon of these cases has been determined rather by matter of habit, than by the exigencies required, as scientifically proved, in each individual case, and each operator has had recourse, for instance, either to



Fig. 1 Fracture of the left femur at the middle part.

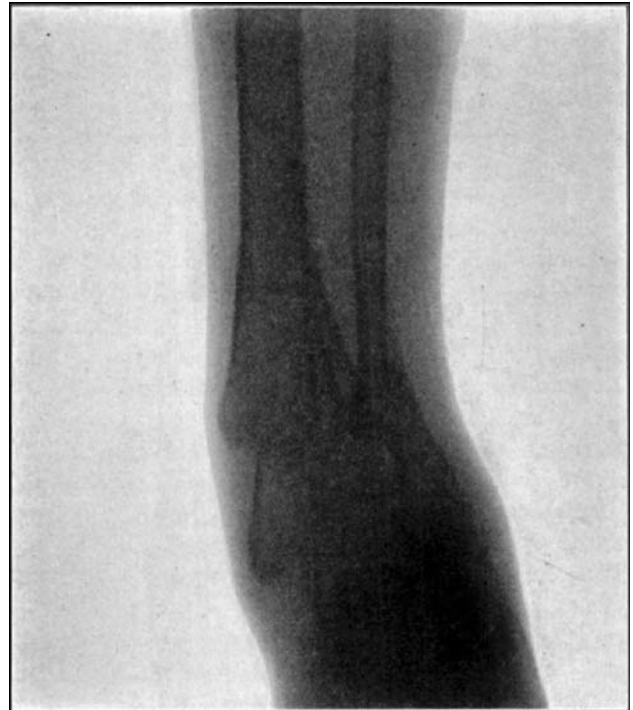


Fig. 3 Deformity from fracture of the third lower part of leg.



Fig. 2 Oblique osteotomy on neck of the fracture. Same case as Fig. 1.

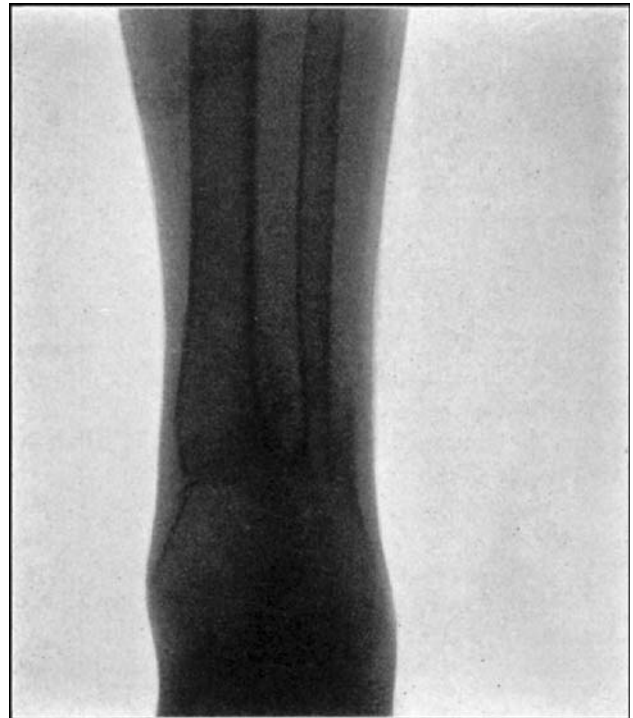


Fig. 4 Deformity from fracture of the third lower part of leg. Same case as Fig. 3.

the plaster apparatus, or to continued traction, according to his opinion as to which of these usual methods is best, in the treatment of recent fractures; and for the same reason he has applied either light or heavy weights.

It is now time that we should earnestly endeavor to free ourselves from blind and empiric custom, and discover the means of lengthening the tissues to their greatest possible



Fig. 5 Deformity from fracture at the third upper part of the right femur.

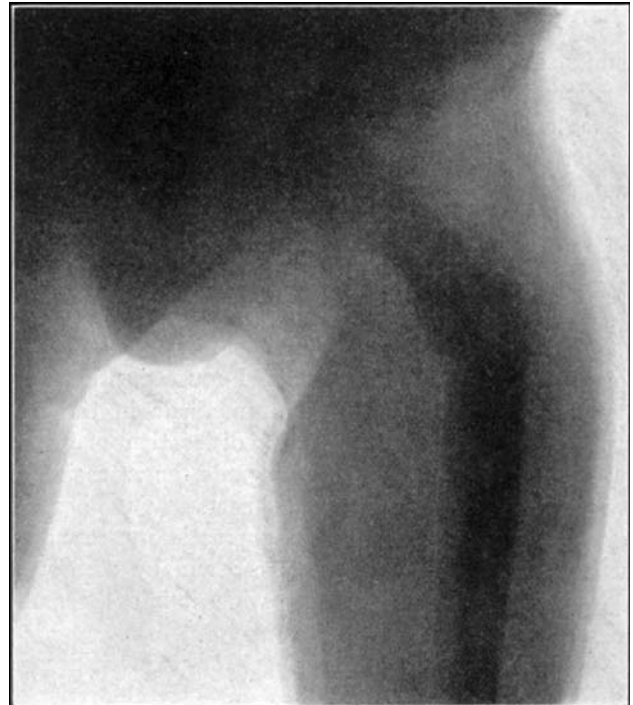


Fig. 6 Osteotomy and traction (nail in the heel). Limb augmented eight centimeters in seventeen days. Same case as Fig. 5.

extent, while compatible with the maintenance of their physiologic functions. The solution of the questions on which I have already partly touched, and which gives us a scientific basis from which to resolve the problem, can be arrived at by experiments on animals, and by clinical observation.

Now, given that we acquire exact knowledge as to the action of the muscles and tissues when subjected to tensile force, without the alteration in any way of their physiologic functions, it will be possible for us to determine approximately what may be the degree of force necessary for extending the fleshy parts to their maximum extent on a given portion of limb, without injuring their functions. In dealing therefore with the case of a shortened limb, we must first determine what lengthening may be necessary in order that it may regain its normal size. This may be proved mathematically.¹

When once we shall have mastered this point, we will be in a position to decide as to the degree to which the limb is capable of being lengthened, and to determine what force is necessary for the corresponding extension of the fleshy parts.

Even admitting that we possessed the knowledge which at present we have not, practically, we could not solve the problem with mathematical accuracy, on account of the many intricacies which surround it, but we might at any rate arrive at some conclusion, which would serve to guide

us, and help us to emerge from the darkness and uncertainty in which we at present are.

Until now the want has not been felt, of solving this problem precisely, because, while at the same time desiring to determine the degree of force required, there were many other things to be considered, besides the question of the resistance of the muscles, and of their action when subjected to tension. In fact, the force which was transmitted to the bones through the medium of the skin, and other soft tissues with which they are covered, was greatly lost in attritus, and through other resistance, whilst a considerable amount of force also did not reach the skeleton, being eliminated in the attritus developed by the lying of the limb on the plane of support.

Then again there is a great limitation in the degree of tensile force which may be applied to a limb, by reason of the inability, on the part of the patient, to bear, beyond a certain limit, the pain proceeding from the drawn or compressed skin. This has not even been taken into consideration in determining what force is necessary for the extension of the tissues, to their maximum length, while compatible with the maintenance of their normal functions, which constitutes the rational limit to the intensity of the force which may be applied. Now in order that we may be enabled to proceed, in an ideal way, toward the desired extension of the fleshy parts, it is necessary to remove all the causes, which, without justification, limit, or waste, the force, physiologically possible to be applied.

¹ See *Archivio di Ortopedia*, fascicolo 3°, 1904.

Fig. 7 Deformity from Coxa vara.**Fig. 8** Deformity from coxa vara after operation. See Fig. 7.

I am of the opinion that an important step in this direction has been gained by my method of applying the force directly to the skeleton.

Before however speaking of this, I must mention that by experience gained through modern methods in the cure of deformity—especially of congenital dislocation of the hip—I am convinced that in so far as regards the extension of the fleshy parts, and when great force is necessary, the best results are obtained from forced lengthening, practised under narcotics; by using a sudden and intense force; and by then applying the plaster apparatus to the limb while it is still maintained in complete extension.

I therefore hold that preference should be given to this method.

But in cases of great shortening, or where the resistance is conspicuous, I believe it would be dangerous to actually operate with a tension which is extraordinarily great, in order to obtain an immediate lengthening of the tissues, sufficient to remedy the shortness of the limb.

There is also danger by excessive extension of the soft tissues, from the reaction which occurs in the central nervous system; a reaction which shows itself, according to my experience, in convulsive attacks, which commence after a lapse of time (two or three days), from the period at

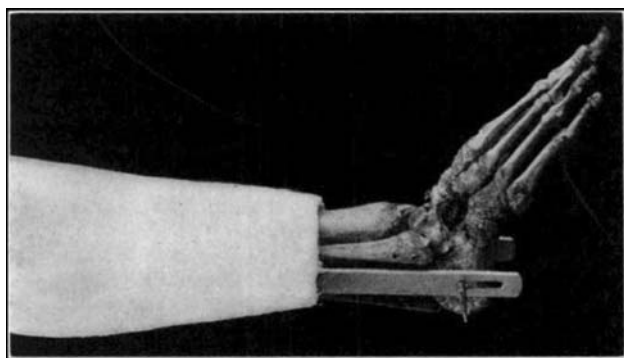


Fig. 9 A photograph, in which is represented the lower part of the apparatus, composed of the ferrules and of the nail.

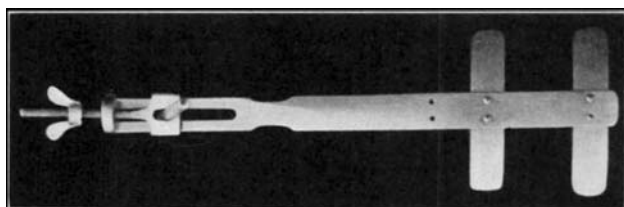


Fig. 10 A photograph which shows the ferrule in detail in its union with the nail. The screw is to serve only for diminishing, and not for augmenting, the traction, in cases in which for some complication it may be found necessary.

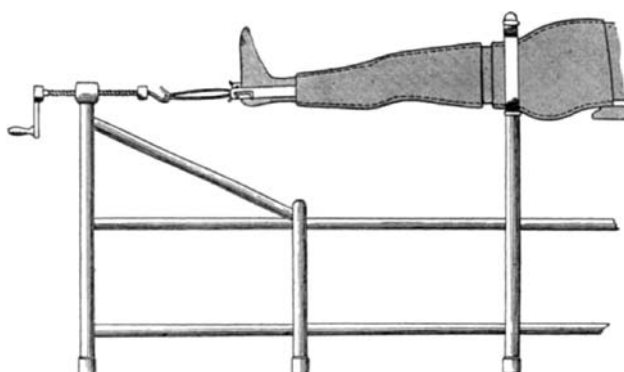


Fig. 11 A diagram which shows the whole apparatus at work, while the traction and the counter-traction are applied to the two portions of the plaster apparatus.

which the force was first applied, and which may become so serious as almost to constitute a state of epilepsy, and which necessitate the cessation of the traction.

In these cases, therefore, instead of applying a too powerful traction, it is better to proceed to the act of lengthening by stages, followed by the application of a traction of medium intensity (not exceeding 25 or 30 kilograms). This mode of extension by stages, removes the inconveniences which arise from excessive traction, and enables us to overcome the resistance, by means of a proportionately lesser force; because in its every fresh

application there is a decided gain in the extension of the fleshy parts, to which the elasticity of the tissues in a certain way is adapted. The following was first the method of technical application:

Having, if necessary, performed the osteotomy, and removed the splinters, etc., and in a word executed the operation which removes the resistance offered by the bones to the process of extension, the patient was placed on a Schede-Eschbaum bed, and the limb was subjected to traction, and to counter-traction. The force adopted ranged from 25 to 75 kilograms.

Under the action of this force, the fleshy parts were extended, while a plaster apparatus was applied, which encircled the pelvis, and reached to the foot, which it enclosed. In order that the traction should not be interrupted during the time in which the plaster apparatus was being prepared, some days before the operation was performed a plaster bandage was applied, which covered the foot, and the lower half of the leg.

The traction was thus applied above the plaster apparatus which covered the foot, whilst the plastering, without interrupting the traction, was completed in that part which had to enclose the rest of the limb, and the pelvis. When the apparatus was solidified, the traction was withdrawn, and the force continued to act upon the limb by means of the detracting action of the said apparatus.

After a few days' time a new detracting force was applied, in the following manner:

The plaster apparatus was cut circularly, by means of a saw (*filo sego di Gigli*), so as to correspond with the division of the bone, and the traction and counter-traction were directly applied, respectively to both the nearest and the farthest portions of the plaster apparatus. These were thus separated the one from the other, and the limb was lengthened correspondingly.

With this fresh application of the traction, the soft parts underwent a further lengthening, and in the same manner in which the first application of the force had been made, the detracting action was left to the apparatus, so soon as this had been completed. Thus the space left empty by the separation of the two parts, was filled up by a few windings of the bandage round the limb.

The application of the force could then be repeated as many times as was considered necessary, either under narcotics, or without, according to the needs of the case.

But the method of application in this manner, which I applied in my first cases, gives rise to inconveniences.

I have already spoken of the general derangement of the nervous system, which followed, when the traction had been very intense (50 to 75 kilograms).

But there was another complication which it was impossible to remedy, without modifying the technic of the method. This was that the compression used upon the



Fig. 12 Deformity from fracture of the femur. Longitudinal and angular displacement. Shortening of 5 centimeters.



Fig. 13 Deformity from fracture of the femur cured. Complete disappearance of shortening and of every deformity.

instead, upon the ankle, and upon the heel, led to necrosis of a large surface of the skin, and of the tissues (including the tendons), which lie between it and the bones.

These places are those in fact, upon which the force acts with the greatest intensity, because the lengthening of the limb is maintained by the resistance which the apparatus offers to the foot, which has a tendency to draw up, under the tensive action of the soft parts.

This applies so far, to the traction. The counter-traction on the other hand when applied to the base of the limb, has at its disposition a larger surface to rest on, and upon those parts of the bones which are (with the exception of the ischion), very well protected by the covering formed by the fleshy parts. And for these reasons the pressure exercised by the apparatus upon the base of the limb is without the grave consequences it has, when applied to the foot.

Thus it was possible to continue the application of the counter-traction in the same manner, while with regard to the traction, it was necessary to find the means of permanently removing the dangers of necrosis, which followed seriously upon the compressing action of the apparatus, however great the care which had been taken in applying it. To gain this end it seemed to me necessary to transmit the force to the skeleton, thus excluding the skin, and the other soft tissues of the foot, and to arrive directly at the bones.

I have obtained this direct transmission of the force to the skeleton, by means of a large nail being passed through the back part of the heel; a nail, which by means of two lateral ferrules, fixed in the plaster apparatus, is held in the desired position.

The diagram shows better than any description can do, the position of the nail with regard to the skeleton, and to the apparatus.

Experience has demonstrated that the traction transmitted to the skeleton by means of the nail passing through the heel, does not present any inconveniences, and fulfils the desired effect. There have been a great many cases in which both by me, and by others, this method of traction has been put to the proof.

The nail, even if it be of the thickness of 5 or 6 mm. in diameter, is easily passed through the bone, without fracturing it; and is well borne by the tissues, even during a long period of time (thirty to thirty-five days, though on an average it has been applied for about twenty days). It does not produce any ill effects upon the bone (decubitus) worthy of note; it does not cause any painful sensations to the patients; permitting them movements in the tibio-tarsal articulation, and in the other articulations of the foot.

By reason of the position which it occupies between the longitudinal axis of the tibia, and that of the tricpite surale, it maintains the foot in an intermediary state between flexion and extension, and does not in any way injure its function.

The method thus modified, renders possible a far stronger application of the traction, than has ever yet been obtained, and permits the lengthening of the fleshy parts of

a shortened limb, without its giving us any anxiety and without other limitation in the application of the force, save only for the harm which it might cause to the physiologic functions of the tissues to be lengthened.

By this method we have obtained in all cases the constant fulfilment of our desires, *viz.*: the important lengthening of from 3 to 8 cm., which, I believe I can well affirm, could not have been arrived at by other means.

I insist upon demonstrating the complete harmlessness of the application of the nail, in the manner indicated, and of the ease with which it is borne by patients. Thus being myself quite convinced as to the efficacy of the method of traction which I recommend, I should greatly regret the hindering of its being put to the proof, by reason of any preconceived ideas on the subject, which at the first moment may arise.

I mention some cases which I have cured by the foregoing means and show some radiographs and photographs.

The cases in which I applied the method, including 8 cases operated on by Dr. Rossi and Professor Galeazzi, were 26, of which 11 were old fractures of the femur, healed with deformity, and with notable shortening; coxavara (congenital, due to rickets, and deformity from youth), cured by my process of osteotomy *a cerniera* (turning-

joint) and traction on the nail; 5 cases of shortening from other causes, stoppage of growth, dislocation after typhus, rickety curvature, etc.; 3 old fractures of the leg, 1 pseudoarthrosis on the upper third of the leg with notable displacement of the fragments; 2 fractures above the ankle, with serious lateral deviations. In these cases of fracture of the leg, the traction on the nail was applied at the same time as the operation on the bones, and it is to this fact alone that we owed our success.

In these cases no new applications of the distensive force were continued.

In one of these cases, with the object of keeping the part more firmly immovable, and to obtain a good effect from the apparatus upon the evil tendency toward rotation of the most distant portion of the limb, two nails were fixed, one in the heel, and the other in the upper part of the tibia, and these were enclosed in the plaster apparatus.

The method has borne the very best results, correcting the deformity, and diminishing, or completely removing the shortness of the limb. In cases of fracture of the femur, or in oblique osteotomy, the lengthening of the limbs has varied from 3 to 8 cm. After the traction on the nail has been accomplished the method has left no ill effects of any kind.