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JOHN C. SCHAPPS, M. D.,

Surgeon to the Department of Orthopædic Surgery and Diseases of the Joints, St. Mary's Hospital, Brooklyn, N. Y.

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THE MECHANICAL TREATMENT OF POTT'S DISEASE OF THE SPINE,

IN THE SUBACUTE OR CONVALESCENT STAGE.*

By JOHN C. SCHAPPS, M. D.,
SURGEON TO THE DEPARTMENT OF
ORTHOPÆDIC SURGERY AND DISEASES OF THE JOINTS,
ST. MARY'S HOSPITAL, BROOKLYN, N. Y.

Physiological rest of the spine is possible only in the recumbent position, and during the acute or soft stage of Pott's disease this position, with adjusted pressure and, if necessary, traction, should be uninterruptedly maintained.† But when for several months the deformity has shown no increase, the patient has eaten and slept well, enjoyed good general health, and, most important, the spine outside the diseased area has regained its flexibility, the convalescent stage may be considered as entered upon, and recumbency may be gradually and carefully exchanged for the upright position. This transition involves the bearing of weight, and that frequently at a mechanical disadvantage because of deformity. It involves, also, a constant sub-

* Read before the Orthopædic Section of the New York Academy of Medicine, January 18, 1895.

† Recumbency in the Treatment of Pott's Disease. *New York Medical Journal*, October 21, 1893.

jection to adverse muscular action and external traumatism. It is therefore a period of great danger, and it is well for the friends of the patient to understand that, however long it may have been delayed, the upright position is always an experiment, and that it may be advisable at any time to return to recumbency.

If, on the flexible back of a child, the distance along the spine from the base of the skull to the sacrum be measured in the upright and in the flexed positions, it will be found that in the latter it is longer by several inches. This increase represents the total separation of the tips of the spinous processes. So far as antero-posterior motion is concerned the spine may be regarded as a series of short bones hinged together. The spinal cord is secured in its canal throughout the whole length by the nerves. There is no slack in the lower nerves to be taken up by traction on the cord, but, on the contrary, they extend from their origins directly downward before emerging from the canal. If the axis of motion between these short bones were behind or in front of the cord the bones would be separated and the cord subjected to dangerous stretching during either posterior or anterior flexion. It is probable, therefore, that the axes of antero-posterior motion pass transversely through the neural canal. It is a matter of common observation that in Pott's disease symptoms denoting lesion of the cord or its membranes have no fixed relation to the acuteness or amount of deformity; and pathological specimens show that whether the kyphos be more or less angular, the caliber of the canal is not usually affected. The axes of deformity must therefore be the same as those of normal antero-posterior motion. The lateral deviation which may have been observed in the acute stage is to be regarded as an irritative muscular symptom rather than a unilateral loss of bone, and is gradually

lost in the antero-posterior deformity characteristic of this disease.*

In the application of mechanical support to the upright spine, if we could grasp the spine directly we would immobilize it and apply forward pressure to the real or prospective kyphos; backward pressure to the parts above and below, with traction and counter-traction. But as we can not, it is necessary to study the nature and relations of the parts through which our mechanical remedies must reach the spine. The relative merits of traction and leverage have been frequently discussed. It is, however, evident that force or support, whether applied in a horizontal direction as leverage or vertically as traction, can act on the spine only by a motion the reverse of that of the deformity and around the same axes. And until this curvilinear motion has reached its limit traction can not tend to distract. Even then the tractive force can not be equal to the weight of the parts above the diseased area plus the resilient force of the ligaments and muscles binding the vertebræ together, for this necessitates a pressure greater than the skin can bear. It is then simply a question of utilizing every square inch of available body surface for the application of both leverage and traction. Let us consider the areas of possible application for remedial force or support. Pressure forward is to be applied to the kyphos, or at the situation of a possible kyphos. Pressure backward may be applied to the forehead, chin, thorax, shoulders, and anterior edges of the iliac bones. Pressure upward, or traction, may be exerted on the chin, back of the head, and under the shoulders. Pressure downward, or counter-traction, is applicable to the shoulders, iliac crests, and the projecting gluteal muscles. The question of pressure upon the abdomen made with a view to spinal sup-

* Lovett. *Trans. of the Am. Orthop. Assoc.*, vol. iii, 1890, p. 187.

port or correction demands careful consideration. By virtue of the arrangement of layers of the abdominal wall it does, under conditions of muscular tension, have a certain degree of cylindrical firmness. When there is a projection forward of the lumbar spine and abdomen accompanying a dorsal kyphos, if the lumbar spine is very flexible it may be somewhat straightened by backward pressure upon the abdomen; and abdominal pressure may serve also in extreme deformity to supply, through the viscera, some degree of internal support for the chest wall and also for the spine. But the abdomen is like an air cushion in front of the spine, and pressure applied to it is not transmitted in a straight line, but is exerted, more or less equally, in every direction. Internal tension in the thoracico-abdominal cavity is necessarily exerted somewhat upon the diseased spine, which is a weak spot in the parietes, and tends thus to increase its pressure against the external support. And as instrumental support is limited entirely by the pressure-toleration of the skin, internal tension becomes a consideration. But abdominal pressure is far more serious, because of its interference with the circulation and respiration, and its tendency to produce visceral displacements and hernia.

In cervical or high dorsal disease the trunk grasped as a whole, and the head, respectively afford good means for the application of remedial force or support, both vertical and antero-posterior. The shoulders, although indirectly and loosely attached to the spine, may be made to sustain to some extent the weight of the parts above them. Axillary support from the pelvis is also of some relief to the spine below the shoulders.

In mid or upper dorsal disease a very prominent part of the deformity is that of the chest known as pigeon breast. Its mechanism is probably this: The upper ribs are more horizontal than the lower, which incline downward

from the spine. As the vertebræ above the apex of the kyphos drop down, they tilt downward the upper ribs, which in turn tend to carry down the upper end of the sternum. At the same time the lower ribs are tilted upward and their normally greater inclination downward with their length causes the lower end of the sternum to be carried forward. Thus the forward inclination of the sternum is increased, and as this bone is fixed at its ends the front extremities of the intervening ribs are also fixed. Projection backward of the vertebræ serves to draw on these ribs so that the backward projection of the latter at their angles, or the forward projection of the spine into the chest, is diminished and the two sides of the back become like the sloping sides of a roof, of which the spine forms a curved ridgepole. The chest is elongated in the posterior direction and contracted laterally. This change is usually most marked in the lowest part. When, as the result of great spinal deformity, the entire trunk is considerably shortened, the chest sinks down upon the abdomen. I have watched the respiration in such a case and observed that as the diaphragm contracted the central part resting on the abdominal organs became the fixed point, and the contraction raised the chest and head. Under such circumstances the muscular and tendinous structures connecting the lower front of the chest to the front of the pelvis are relaxed and no longer serve to tie down the sternum. The posterior surface of this bone and the adjacent costal cartilages are now resting upon the abdominal contents, and this weight of the superincumbent parts tends to increase the abnormal forward inclination of the sternum. When the upper dorsal spine is inclined forward, the head, to preserve the equilibrium, is drawn backward, and thus the deformity is made more conspicuous.

In dorsal or lumbar disease the mechanical problem is

to apply to the trunk itself forces acting in different directions; and as backward pressure can reach the spine only through the medium of the chest and pelvis, the foregoing analysis of thoracic deformity should be kept in mind; for, by a direct backward pressure on the sternum with forward pressure upon the kyphos, the lower ribs are pressed downward in front, and through the ribs as levers a powerful corrective force is brought to bear upon the spinal deformity.

The theory upon which pressure is made on the kyphos has been that of keeping the diseased part as nearly as may be in its natural relations with the parts above and below. But in dorsal disease it is evidently important to keep it in its normal relations also with the parts on either side. This is possible only by the use of direct backward counter-pressure applied to the front of the chest. Such pressure has no injurious effect upon the

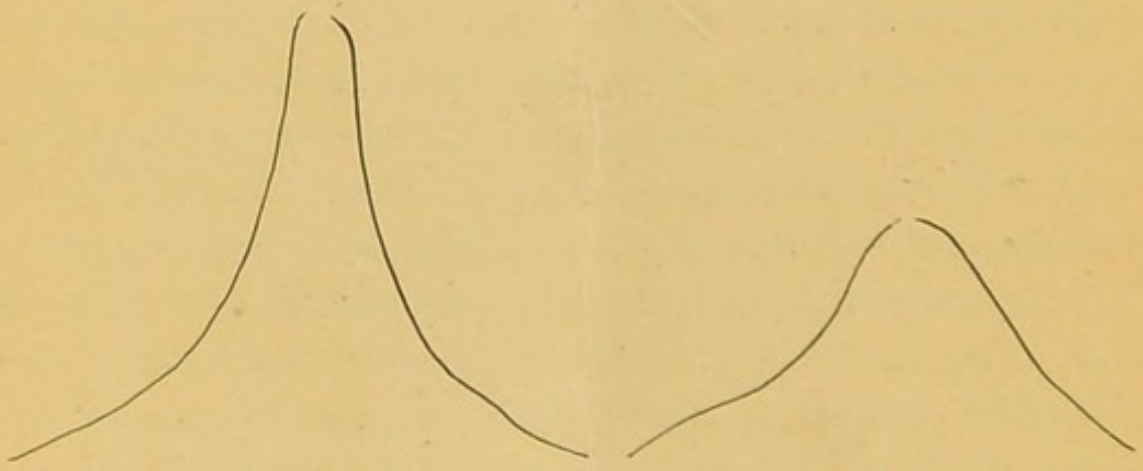

Fig. 1. Fig. 2.

A contraction of the lower thorax with a small substernal angle is thus induced. Fig. 1 shows this angle in a man twenty-nine years old, who had worn a constricting brace for two years. Fig. 2 is the angle in a boy nine years old who had never worn a brace.

thoracic respiration, as respiratory movements of the ribs are chiefly performed by a rotatory movement around a straight line uniting the vertebral and sternal extremities;

and in so far as the pressure tends to shorten this line and restore the convexity of the ribs, it increases the respiratory function. The evils of circumferential pressure applied to the trunk are self-evident. Besides interfering with respiration and producing internal tension with its consequences mentioned, it induces a permanent contraction of the lower thorax and a small substernal angle. This has been held by such eminent authority as Laennec to be a predisposing condition to phthisis pulmonalis. In a patient with a tuberculous bone lesion it is a very serious matter.

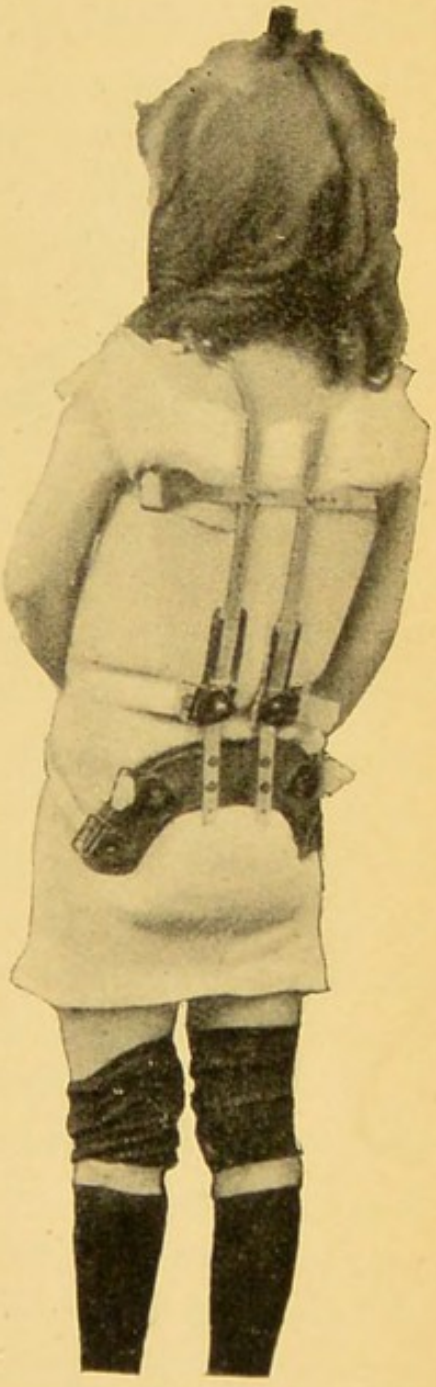

Fig. 3.

In the treatment of lumbar disease no new principle is involved. It is still a question of exerting anterior pressure on the kyphos, with posterior pressure above and below. Here the superior mass is so great as to make traction of little or no service.

The apparatus which I employ to meet these mechanical indications is here presented. Posteriorly it is the Taylor brace (Fig. 3) with some unessential modifications, not my own, made with a view to simplifying it. Instead, however, of securing it to the trunk by a soft apron, which exerts a large amount of circumferential pressure and a minimum of posterior pull, I apply a rigid support in front (Fig. 4), and the trunk is

sandwiched between two braces, which are drawn directly toward each other. For the reasons given above I have avoided, as a rule, abdominal pressure. An additional rea son for leaving the abdomen uncovered in front is that distention from food, gas, etc., would tend to lift the brace from those parts where its pressure is most efficient. Commencing with the lower end, the anterior brace presents a steel band passing across the abdomen and well around the sides of the pelvis, as low as is possible without its being displaced by the thighs when the patient sits. The anterior-superior spines are protected by thick pads of kersey and leather, and the central part of the band is arched so as to prevent pressure on the abdomen. It is essential that the band should bend sharply around the front edges of the ilia and fit tightly against the sides of the pelvis for about an inch. By means of straps at the ends of the band it is connected with the hip band of the posterior brace, and the pelvis is literally clamped between the two bands, which nearly meet at the sides. At the location of the anterior-superior spines two flat uprights are riveted at right angles, or, if the abdomen is very protuberant, they are directed outward from the lower band. The curving of this band permits the uprights to be approximated above.

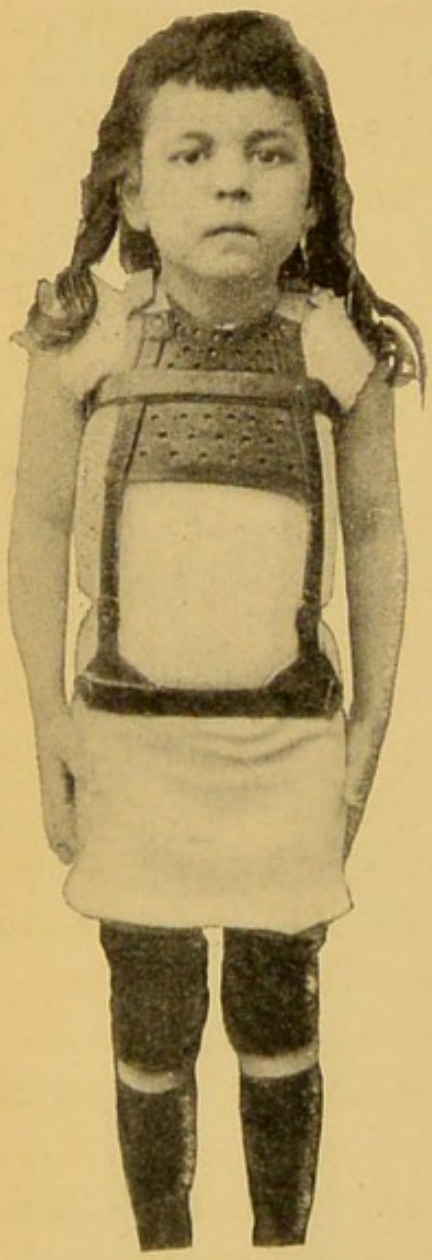

Fig. 2.

They extend upward and inward along the abdomen and chest to the infraclavicular spaces. At the level of the axillæ they are crossed by a flat bar, which passes across the front of the chest and nearly through the axillæ at each end. No. 16 spring steel is a good material for the construction of all parts. Near the level of the chest band three holes, drilled three eighths or half an inch apart, will save trouble in placing the band, which should be fastened by iron rivets. The abdominal band should be an inch, the others half an inch, wide. These dimensions are for children. It will be more convenient to have the separate parts covered with leather and then fastened together. In measuring one is very apt to locate the chest band too high, as well as to make the whole front brace too tall. It is very instructive to note how far the anterior chest wall will, notwithstanding all possible pressure, sag down in the upright position. It demonstrates strikingly the mechanical advantages of the supine position with reference to traction. At the upper ends of the uprights are straps which pass over the shoulders to buckles on the shoulder pieces of the posterior brace, and from the ends of the chest bands straps running backward buckle to the cross-piece of the brace. This cross-piece extends to the posterior edges of the axillæ. Behind the upper part of the apparatus is a stiff leather perforated chest piece, which is secured to the uprights and covers the front of the thorax as far down as the ensiform cartilage. In some cases I have supplemented this by bands of aluminum or leather passing from upright to upright across the abdomen, but, for reasons given, it seems, as a rule, best to leave the abdomen free. Near the lower ends of the uprights are web straps (commonly padded) which extend over the crests of the pelvis to the buckles on the spinal uprights behind. These and the hip band of the posterior brace

afford all the vertical support anatomically possible. The ends of the bar passing through the axillæ may be padded as axillary crutches. Or from the ends of the shoulder pieces the regular round, padded shoulder straps of the Taylor brace may pass through the axillæ and back to a second cross piece placed just below the first. The perforated chest piece can be made to fit accurately by bandaging it while wet to the chest, oiled silk being interposed. In high dorsal and cervical cases the head support which I prefer is Taylor's, without the ball-and-socket joint, the slipping of which is a continual annoyance. In its place I use a pivot, flattened below, to slide in a keeper fastened to the uprights. This pivot has a soft neck which may be bent easily in any direction. This is, I believe, the original device of Dr. C. F. Taylor. Thus constructed this combination of anterior and posterior braces constitutes a skeleton support, to which parts may be added to meet the individual requirements of a case or the special views of the surgeon. If a greater area of lateral support be required it may be secured by a series of straps from the anterior to the posterior uprights. I think, however, that in Pott's disease lateral curvature from muscular spasm is best treated by recumbency.

It is claimed for this combination:

1. That all the available space is utilized for the application of force, both of leverage and traction.

2. The force applied for the purpose of leverage is expended entirely in the antero-posterior direction.

3. The anterior and posterior braces nearly meeting at the sides, lateral support is amply provided in every case where recumbency is not needed.

4. The grasp of the trunk, as a whole, for the purpose of counter traction in disease of the upper spine is as complete as possible.

5. There is an absence of circumferential pressure, so that the abdominal, diaphragmatic, and lateral thoracic movements are unobstructed.

6. The directly backward pressure of the leather apron serves:

(*a*) To antagonize any tendency to an anterior protrusion of the chest.

(*b*) To exert through the ribs a leverage upon the diseased vertebræ.

(*c*) To preserve or restore the normal postero-latera. curvature of the ribs, and so enhance the respiratory functions, and to keep the diseased spine in normal relations to the posterior chest wall on either side.

7. The back or any other part of the trunk can be at any time readily inspected.

8. The apparatus can be easily modified and pressure on any part accurately adjusted.

9. It is so simple that any blacksmith can make it.

10. The functions of the skin as a respiratory organ are respected.

I use also rubber heels in conjunction with this apparatus to minimize concussion, diminish direct traumatism, and save reflex muscular action.

The question, "How long should a brace be worn?" is difficult to answer, even in each particular case. On the one hand, increase of deformity, or the evidence by face, attitude, or gait that the patient is not getting the proper support, should be the indication for a return to the recumbent position.* On the other hand, the continued absence of symptoms of active disease, the general activity and well-being of the patient, afford the best possible reasons for the watchful and gradual removal of support.

498 Bedford Avenue.

* Recumbency in the Treatment of Pott's Disease. *New York Medical Journal*, October 21, 1893.