AN OPERATION FOR POTT'S DISEASE OF THE SPINE*

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The treatment of Pott's disease, or humpback, by immobilization of the diseased joints has long been the accepted method and is accomplished by various mechanical means, such as braces, plaster-of-Paris jackets, etc. That much success has been obtained by these means there is no question. That there is still much to be desired is equally unquestionable, because these various methods, while they limit motion, do not secure absolute immobilization of the diseased joints or entirely relieve pressure on the involved bodies; for this reason it is necessary to continue treatment for long periods of time, and in almost every case the deformity increases more or less, especially in the dorsal region. It would seem, therefore, that a method of treatment which would absolutely eliminate motion of the diseased vertebræ and entirely relieve pressure on the involved bodies promises more rapid cure of the disease and prevents deformity.

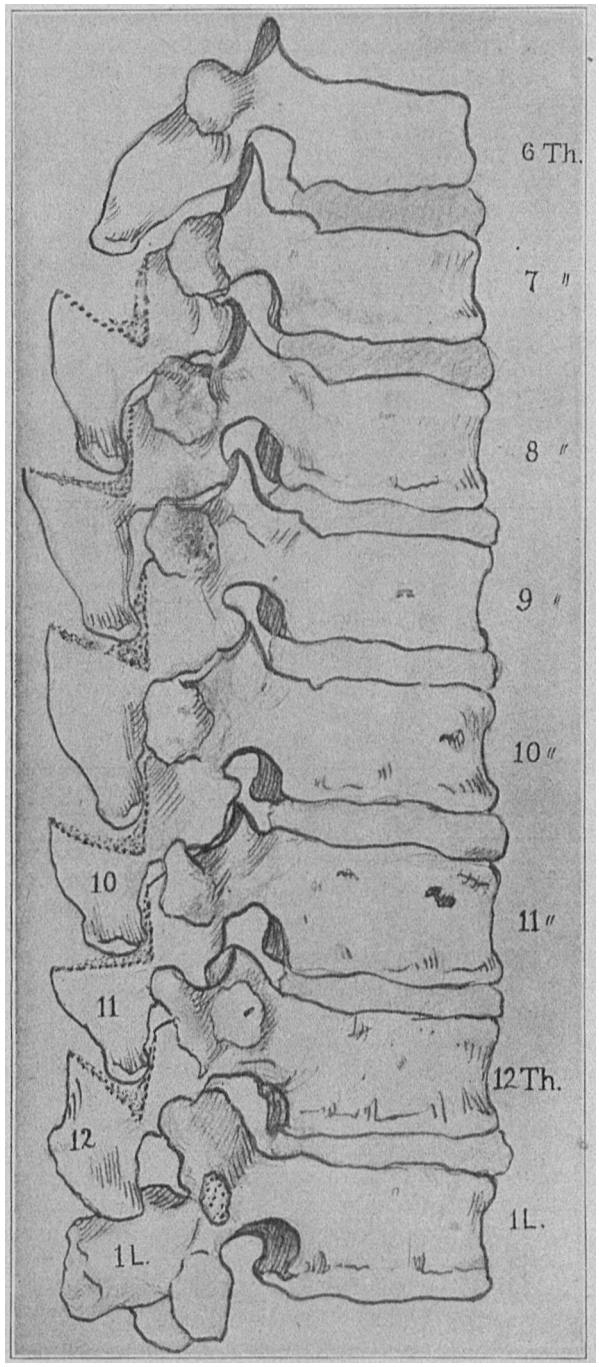
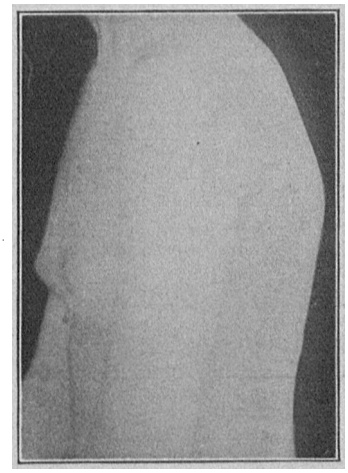
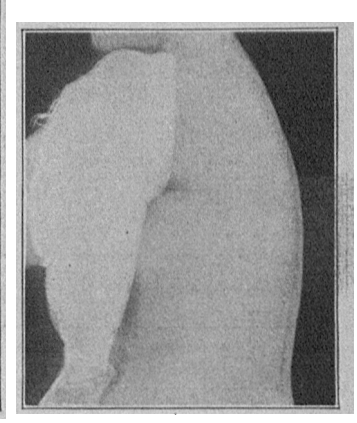


Fig. 1.—Spinous processes partially fractured and used for bridging the gap between the vertebræ.

The disease, being confined to the bodies of the vertebræ, leaves the posterior aspects, laminæ and spinous processes unaffected. It was thought that an operation on this healthy bone-structure offered an opportunity of producing a fusion of the laminæ and spinous processes which would accomplish the desired result. The operation was suggested to me by my experience in the use of an operation, involving practically the same principles, for stiffening the knee-joint by mortising the patella into the joint after it was denuded of periosteum.[1] The patella periosteum was carefully preserved and sutured to the periosteum of the femur above and to that of the tibia below. In these cases continuous bone was produced between the femur and the tibia, obliterating the joint. I thought that, in the spine, the careful removal of the periosteum of the spinous processes and the laminæ, with the spinous processes transposed to bridge the gap between the vertebræ and with the gaps between the laminæ also bridged by bone, would lead to extensive formation of bone, fusing the vertebræ. It is important to observe that in the case of the spine, the gap to be bridged between the laminæ and the spinous processes of any two adjacent vertebræ is very narrow.





Figs. 2 and 3.—Girl, aged 16; mid-dorsal disease, four months' duration; left, before operation; right, eight months after operation.

After experimental work on the cadaver in the laboratory of Dr. George S. Huntington, at the College of Physicians and Surgeons, New York, during the fall of 1910, the first patient, a boy, aged 9, with disease of the second and third lumbar vertebræ, was operated on Jan. 9, 1911, at the New York Orthopædic Hospital. A preliminary report[2] was made of this case, with two others, in which I stated that it might possibly be necessary, in the very young, to graft bone from the tibia. This feature of the technic has since been practiced by

* Read in the Section on Surgery of the American Medical Association, at the Sixty-Third Annual Session, held at Atlantic City, June, 1912.

1. Hibbs: Operation for Stiffening the Knee-Joint, Ann. Surg., March, 1911.
2. Hibbs: New York Med. Jour., May 27, 1911.

Albee and Whitman of New York. The former[3] reports three cases, the first operated on June 9, 1911; the latter, Whitman,[4] reports a case operated on Aug. 11, 1911.

I have not used a bone graft as yet, as it has not seemed necessary. It is obviously an advantage not to do so if the desired result may be accomplished without it.

In performing the operation, a longitudinal incision is made directly over the spinous processes, through skin, supraspinous ligament and periosteum, to the tips of the spinous processes. The periosteum is split over both the upper and lower borders of the spinous processes and the laminæ, and stripped back from them to the base of the transverse processes. The spinous processes are then transposed after partial fracture, so that they make contact with fresh bone, the base of each with its own base and the tips with the base of the next below. The adjacent edges of the laminæ being absolutely free from periosteum, a small piece of bone is elevated from the edge of the laminæ and placed across the space between them, its free end in contact with the bare bone of the laminæ next below it.

Figure 1 is a lateral view of the transposed spinous processes.

The lateral walls of periosteum and the split supraspinous ligament are brought together over these processes by interrupted chromic catgut sutures. The skin wound is closed by silk, and a steel brace applied, with the space between the uprights increased somewhat at the site of the wound, so as not to make pressure on it. In some cases the gaps in the periosteum removed from the spinous processes and laminæ have been closed by suture, thus establishing at once a continuous periosteal wall. With the bone bridge established, I doubt the necessity of this practice.

Rest in bed is absolute for from eight to ten weeks. During the next four weeks, sitting up is permitted. At the end of the twelfth week, walking is allowed. The brace is continued for another month, when it is removed for a part of each day until gradually left off entirely. With children under 5 it should be worn for six months.

The number of vertebræ in each instance included in the operation is determined by the extent of the disease. It is necessary always to be sure of attaching the diseased vertebræ at either end of the involved area to healthy ones above and below. The extent of the disease may be determined accurately in some cases by *x*-ray pictures. When this is not possible, the only guide is the kyphos or the region of rigidity. It is a fact that all the vertebræ involved in the kyphos are not diseased and that inaccuracy in the number of vertebræ to be operated on is possible. But care should be taken to include a sufficient number, as otherwise the elimination of motion of the diseased joints will not be obtained. The stiffening of a small segment of the spine in a given case is not a serious matter in view of the fact that the remaining healthy joints compensate for the loss of function of the few. Indeed, is it not a fact that comparatively few patients with Pott's disease (except in the cervical region) recover with movable joints?

It has long been the accepted theory that the osteoblast was generated from the periosteum and for that reason great care has been exercised to remove it without injury. However, Macewen's[5] experimental studies of bone-growth seem to prove that the osteoblast emanates from the bone. Whether it is generated from periosteum or from bone, or from both, is a question which need not be determined in estimating the value of the surgical procedure under discussion.

We have both structures here in abundance; the operation stimulates the generation of the osteoblast, provides a place for its deposit and nutrition between the periosteum and bone, insures continuous bone formation along the posterior aspect of the vertebræ operated on and produces a fusion of laminæ and spinous processes from the transverse processes of one to those of the other side, thus giving a perfectly symmetrical, extensive and adequate support.

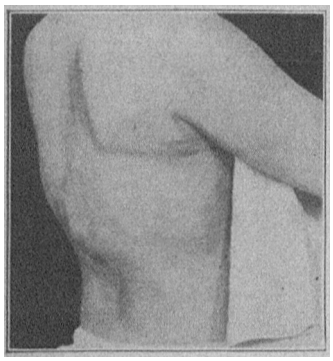


Fig. 4.—Woman, aged 25. Lower dorsal disease, before operation.

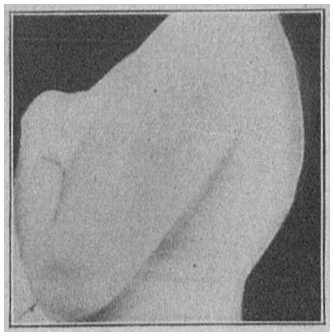


Fig. 5.—Patient (Fig. 4), twelve months after operation.

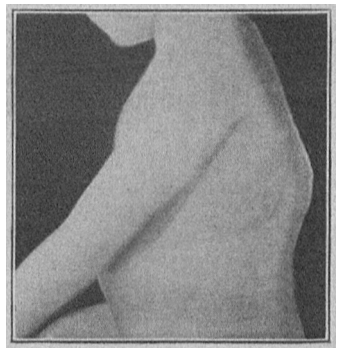


Fig. 6.—Child, aged 5. Dorsal disease, before operation.

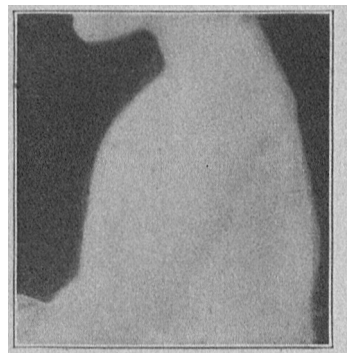


Fig. 7.—Child (Fig. 6), ten months after operation.

My experience of the beneficial effects of immobilization, even when imperfectly obtained by braces and jackets on tuberculous disease of vertebral and other articulations, justifies me in believing that a more perfect degree of such immobilization, produced by bony anchorage of the diseased structures in the desired position, will unquestionably be of the greatest help in arresting and controlling the morbid process, and will eventually lead to a radical cure of the disease.

I have felt justified in continuing this work and have operated on forty-seven patients at the New York Orthopædic Hospital, twenty-eight operations being in the dorsal, six in the lumbar and thirteen in the dorsolumbar region. Twenty-nine patients were from 2½ to 10, fifteen from 10 to 15, one 18, one 25 and one 41 years of age. The duration of the disease has varied from three months to ten years, but in the large percentage, under five. In all, the wounds have healed without complication, pain has been slight and there has been no reac-

3. Albee: THE JOURNAL A. M. A., Sept. 9, 1911, p. 885.
4. Whitman: Ann. Surg., December, 1911.
5. Macewen: The Growth of Bone, Observations on Osteogenesis, an Experimental Inquiry Into the Development and Reproduction of Diaphyseal Bone, 1912.

tion from the operation. Twenty of the patients have been without support for from three to twelve months and have shown no symptoms of disease or any increase of deformity.

While it is too early to make a final report on these cases, several observations have been made in connection with this operative experience, which are of very significant importance. In twelve cases, or over 25 per cent., a fusion of the laminæ and the spinous processes of two or more vertebræ involved in the kyphos was found. Ten of these patients were under 10 years of age, one 2½, one 15 and one 16 at the time of operation. The duration of the disease in one was four months (the patient 2½ years old), in one two years, in eight under four years and in two ten years.

In eleven cases the fusion was of vertebræ in the lower segment of the kyphos, in four of three vertebræ, in seven of two vertebræ and in one of seven vertebræ, the only one in which fusion was complete in producing anchorage of the diseased vertebræ to healthy ones both below and above. This attempt on the part of Nature to eliminate motion of these diseased joints by extraordinary bone-growth, though it was incomplete in all but one, is very important, as it indicates the principles which should guide the surgeon in attempting to produce this result by operation, and suggests that the procedure herein described, which preserves all the structures essential to the development of bone and stimulates their activity, is consistent with those principles.

CASE REPORT

A boy, aged 5, operated on Aug. 23, 1911, had active dorsal disease with a marked kyphos. The operation included the seventh to the tenth dorsal vertebræ, but the patient did not show, however, after a reasonable length of time, the relief of his symptoms that had been observed in the other cases. It was thought, therefore, that enough vertebræ had not been included in the operation to immobilize all the joints involved. He was operated on a second time, Feb. 20, 1912, and the condition found was very interesting. There was a continuous bone-formation extending in length from the seventh to the tenth dorsal vertebræ, and in width from the transverse processes on one side to those of the other, which was the extent of the first operation. The bone-bridge was not disturbed; it was only extended by anchoring the fifth and sixth dorsal vertebræ to it above, and the eleventh and twelfth below.

There are two considerations in connection with this case that are of very great importance: (1) that in this child of 5 there had taken place throughout the operative field extraordinary bone-growth, sufficient to produce a fusion of the posterior aspect of the vertebræ, and (2) that error in the number of vertebræ included was made.

The rapid improvement of the general health has been observed in most of the cases, especially those operated on early in the disease.

No attempt has been made to correct the deformity by exercise of force. The transposition of the spinous processes does diminish the deformity, however, in all cases, and in those of the lower dorsal region conspicuously so. The operation should be done before deformity develops.

It has been possible to demonstrate the fusion in many cases by the *x*-ray, but not in all. It is very difficult to get pictures which can be reproduced, though occasionally this has been possible.

Figures 2, 3, 4, 5, 6 and 7 are from photographs, before and after operation, of three patients, and illustrate the effect on the deformity at different ages and different stages of the disease. For instance, Figures 2 and 3 show a case of mid-dorsal disease in a girl of 16 operated on three months after the disease began, and illustrate the possibility of the prevention of deformity when the operation is done early. Figures 4, 5, 6 and 7 are of patients 25 and 5 years of age, respectively, and show a conspicuous change in the deformity though the operation was done later in the disease.

The fact that twenty of these patients have been without support from three to fourteen months since the operation and show no symptoms of increase of deformity or activity of the disease leads one to hope that the operation will be rapidly curative.

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ABSTRACT OF DISCUSSION

DR. GEORGE S. HUNTINGTON, New York: From the standpoint of the development of the vertebral column and its adult structure, there are several points which may be worthy of consideration: 1. The bony spine and the associated ligamentous apparatus tend to synostotic union of the individual segments under very slight provocation. I have been impressed by the relative frequency of fusion, partial or complete, between two or more vertebræ of the lumbar and lower thoracic groups as observed in the reference osteologic collection at Columbia, containing over 5,000 columns. In many instances the skeletal conditions are otherwise normal, without trace of arthritic or exostotic processes. Dr. Hibbs' operation invades a territory in which natural tendencies are in favor of a good result, with abundant and markedly responsive osteoplastic material ready to hand at the site of the operation. 2. In the younger individuals, I have no doubt that the epiphyseal plates and centers of the spines respond actively to the operative stimulus and contribute materially to the successful results which Dr. Hibbs has achieved. 3. The characteristic cancellous structure of the vertebræ suggests the propriety of securing an osteoplastic bed of the same material for the production of the bridge. This appears to me to have a natural and important advantage as contrasted with the attempt to acclimate a corticalis splint from one of the shaft bones in the cancellous environment of the spine. 4. Spontaneous cure of a slight kyphos involving a single center, by synostotic union of spines and neural arches, has been observed in our material. Dr. Hibbs' operation appears correctly devised and executed to secure the best results by employing the most available osteoplastic material and by taking advantage of the natural tendency toward fusion existing in the region involved.

DR. FRED H. ALBEE, New York: In 1911 I operated, for the first time, on a child at the Post-Graduate Hospital, using a method somewhat similar to that employed by Dr. Hibbs. The spinous processes of the vertebra involved were split longitudinally, and then broken. The right half was broken down and approximated to the left half of the next lower vertebra. Four patients were operated on by this method and the cases were reported in abstract at the American Orthopedic Association, May 15, 1911. The only element in the mechanics of the spine which holds it in extension are the muscular and ligamentous action on the spinous processes as levers. If we hold the spine rigid until bony union takes place, the Pott's disease is cured. Of course, there is a large amount of cartilage in the spinous processes of young children and the union is sure to be slow and no appreciable fixation can be obtained until union does take place. In forty-seven cases I have transplanted a plate of tibia of the same patient into the notch produced by splitting the spinous processes of the vertebræ involved and one healthy one on each side. The spinous process acts as a posterior lever, and each vertebra should be considered as a lever, the spinous process being one arm and the body of the vertebra the other arm. The fulcrum consists of the joints of the spine or the lateral facets. In most cases the spinous process is longer than the body; therefore, if we fasten together the tips of the spinous processes, we will prevent the approximation or crushing of the bodies of the vertebra and the resulting deformity. If the spinous

processes are completely broken or cut at their base the leverage action is lost and the natural stability of the spine is much weakened. The advantages of my bone transplantation operation are that it is very superficial; that it straightens the spine and gives very perfect fixation the moment the operation is done; that it is away from the spinal canal, and that if there is overgrowth of bone, no harm may be done to the spinal cord. I have seen cases in which fractures of the lamina have produced exostosis in the spinal canal and pressure on the cord. This must be avoided. In my method the spinous processes are split *en masse*, and this plate of bone taken from the tibia is placed into the split, acting as a sort of wedge, which holds the vertebra as a splint would. I have not been able to amalgamate the vertebræ in dogs by any other method.

DR. MICHAEL CASPER, Louisville, Ky.: Is there any danger in a patient, 40 years old, of breaking the spinous processes off entirely? Is not the same thing true of the lamina? How does Dr. Hibbs hold in place the piece of lamina which he breaks off?

DR. R. A. HIBBS, New York: After the periosteum is removed from the spinous processes and laminæ and the spinous processes are transposed so as to bridge the gap between them, a bone bridge is also made between the laminæ by elevating a small piece of bone from the laminæ and turning its free end down, so that it makes contact with the adjacent laminæ. After the periosteum is brought back and sutured, both of these bone bridges are held in place by it. It is not necessary in the dorsal region to fracture the spinous processes completely, though sometimes it may be done in the lumbar region; it is always easy to have either end of the transposed spinous process in contact with fresh bone, which is all that is necessary. In all the cases thus far, complete fusion has occurred, demonstrated by skiagrams, by unmistakable clinical evidence of the elimination of motion and by the case operated on the second time. My first idea was, that in very young children it would be necessary to use bone-grafts, but it would seem that we have at hand, at the seat of operation, sufficient bone and bone-producing structures to make bone-grafting unnecessary.

The results I have obtained are sufficiently encouraging to justify a continuance of this work, and I will make a detailed report of every case when a sufficient length of time has elapsed to show end-results.

PHYSICAL INJURIES AS RESULTS OF HYDROFLUORIC ACID

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History.—March 20, 1912, Mr. E. M. A., an instructor in the chemical laboratory of the Iowa State University, while etching glass with a 48 per cent. solution of hydrofluoric acid, sustained an injury to the thumb, index- and middle fingers of the right hand.

Immediately following the accidental application of not more than 3 minims of the acid, the patient complained of a sharp stinging pain on the surface covered by the acid, which gradually gave way to a deep-seated penetrating pain which he described by the Norwegian word, *gjennentraengende.* Accompanying this deep penetrating pain were loss of appetite, a feeling of increased bodily warmth, and a restlessness which gradually merged into an intense nervousness as the pain became more severe. Locally the region attacked by the acid became blackened and sharply defined from the normal tissue.

Examination.—The patient was first seen eight hours after the occurrence of the accident. The superficial pain had subsided, and the deep pain had increased in severity, and was accompanied by local heat, edema and stiffening of the first joints of the three fingers attacked. There was an area of escharotic, blackened tissue separated from the normal tissue by a sharp line of demarcation, a temperature of 103 F., and a general nervous condition.

Treatment.—As I had never had any experience in regard to poison or burn by hydrofluoric acid, treatment could be initiated only on the general principles underlying treatment of corrosive mineral acid injuries, viz.: use of remedies for relief of pain, and use of alkalies to limit action of acid.

Patient was next seen six hours later, fourteen hours after the occurrence of the injury. During these six hours the deep penetrating pain had increased in severity until it had become almost unbearable, the patient walking the floor constantly in his agony. The temperature was 105 F. and the nervous condition was extreme.

For the relief of pain and the control of the nervousness codein was administered every fifteen minutes until narcosis had set in, as manifested by the desired relaxation and finally by sleep. In the meantime, the tissues attacked were painted with a preparation consisting of equal parts of tincture of iodin and hydrogen peroxid, and covered with a light dressing of absorbent cotton and surgeon's gauze.

The use of codein was continued for forty-eight hours, when the penetrating quality of the pain ceased, leaving in its place a dull heavy pain particularly noticeable on pressure of the afflicted parts. With the cessation of the pain the nervous symptoms and the elevation of temperature disappeared.

The external applications were continued every hour for four days, then four times a day for two weeks, when rubber finger-stalls lined with absorbent cotton were substituted for the purpose of protection.

Result.—Resolution was exceedingly slow, final separation of the escharotic tissue taking place in the middle-finger in three and a half weeks, in the index-finger in four and a half weeks, while in the thumb the process required eight weeks for its completion. At the time of writing, ten weeks after the initial lesion, the bony structure and also the first joints are still very sensitive to touch or pressure, this sensitiveness corresponding to periosteum and synovial membrane.

Hydrofluoric acid is produced by the action of sulphuric acid on calcium fluorid; it is classed in special toxicology[1] with the mineral acids under corrosives or irritant poisons. It is an intensely irritating acid gas, and is dangerous when taken internally either in the form of gas or solution; when applied externally even in a dilute solution its effects are disastrous. Its principal use has been for etching on glass in making labels and signs; recently, however, since the introduction of porcelain inlays by dentists, hydrofluoric acid is extensively used to roughen the posterior surface of these inlays in order that they may better adhere, through the cement used, to the surfaces of the teeth to which they are to be attached. Dentists keep this acid in rubber bottles and apply it to the inlays by means of a platinum wire loop, great care being taken to avoid direct contact with animal tissue.

Two deaths have been reported from the inhalation of hydrofluoric acid gas: one that of a chemist at Nancy,[2] the other that of a Belgium chemist.[3]

Three suicides by taking hydrofluoric acid in solution are on record: 1. A man took internally 15 c.c.; death occurred in thirty-five minutes.[4] 2. A glass-sign maker took a gill; death occurred in two hours.[5] 3. A glass-sign maker took a tablespoonful of a 9 per cent. solution diluted; death occurred in one hour.[5] In these three case reports the exact degree of concentration is not given; it is difficult, therefore, to tell the exact amount of this acid in solution which might be called a fatal dose.

Action of hydrofluoric acid on animal tissue when applied locally:

1. Witthaus: Manual of Toxicology, 1911, p. 227.
2. Jour. de pharm. et de chim., 1869, 4s, ix, 446.
3. Rabuteau: Toxicologie, Ed. 2, 710.
4. Tr. Path. Soc., London, 1873, xxiv, 98.
5. Stevenson: Brit. Med. Jour., 1899, ii, 1145, 1376.