the different registers with the least possible interruption. If these interruptions or breaks, as they are named, could be eliminated entirely there would be no necessity for the use of the term registers, and this is the position taken by many of the best vocalists and physiologists. It seems entirely within the bounds of reason to suppose that, in the thoroughly trained larynx, the various adjustments of its parts, complicated though they may be, would be accomplished with sufficient smoothness to enable the singer to go from the lowest to the highest pitch with no appreciable break, and that there would therefore be but one vocal register.

The Falsetto Voice.—The thin upper tones of the voice, containing no appreciable resonance from the chest or other large resonance chambers, have been named the falsetto or false voice, in contradistinction to the well-rounded voice resulting from a combination of the laryngeal with all the various resonance tones. The name for this quality of voice is unfortunate, because it has its place both in singing and in speaking, and it differs from the so-called true voice only in the fact that it contains fewer of the resonance tones.

Whispering.—Another quality of voice that must be considered is that of whispering. It is also the result of a combination of laryngeal with resonance vibrations. But the laryngeal tones arise from a free efflux of breath through a comparatively open glottis, and it is quite probable that the ventricular bands also take some part in this fricative sound. The laryngeal vibrations, however, are not of such a nature as to set up additional vibrations in all the resonance chambers. The whispering voice, therefore, is the result of fricative laryngeal vibrations re-enforced by imperfect resonance vibrations.

Defective Speech.—In the majority of cases the immediate cause of defective speech is a faulty construction of the moulds of speech. The remote causes are often more difficult to determine. In their origin they are either central or peripheral, and cases of long standing are both central and peripheral. A cleft palate, for instance, always results in defective speech, and the primary cause is peripheral, but the effort to adapt the faulty organs to the requirements of speech develops a defective action in the motor and auditory centres of the brain which marks the case as coming under the head of both a central and a peripheral affection. The central affection, of course, is purely functional, but it is often exceedingly difficult to eradicate. The patient must be taught to make correct moulds, and it has been found that, when the peripheral organs are intact, a frequent repetition of this process, continued for a sufficiently long time, will correct the faulty cerebral action and improve the habits of speech.

Stammering.—A somewhat less frequent, though more distressing, affection of speech is stammering. Its primary cause may also exist in the peripheral organs, but it is more often of cerebral origin. So complicated are the nervous processes of speech that the only wonder is that the disorder is not more common. The motor processes of normal speech are for the most part automatic, and a slight weakening, for any reason whatever, of a single muscle or nerve, even for an instant, may completely destroy for the time being the automatic action. This leads to a confusion of mind more or less pronounced, which in turn makes extremely possible a speedy repetition of the faulty action, the consciousness of the utter lack of power to control the mechanisms of speech soon follows, and thus the stammering habit becomes fixed. No two cases of stammering are exactly alike, and therefore the scientific treatment of the affection should include a knowledge of the various methods for ascertaining the abnormal mental and physical conditions giving rise to the affection. In other words, as in faulty machinery of any kind, the weak points should be found and the remedy applied directly to them.

The normal automatic action of the organs must be restored, and this can be accomplished only by slow stages through the intermediation of voluntary action. The patient must first learn to recognize, through the auditory and perceptive centres of the brain, the nature of normal speech, and then he must learn to recognize the sensations attendant upon the motor processes of speech.

G. Hudson Makuen.

LAS CRUCES. See *New Mexico.*

LAS VEGAS HOT SPRINGS.—San Miguel County, New Mexico.

POST-OFFICE.—Las Vegas Hot Springs. Hotel.

ACCESS.—Viâ Atchison, Topeka and Sante Fé Railroad to Las Vegas, thence by branch line six miles to springs. Through Pullman sleeping-cars pass Las Vegas twice a day in both directions. These springs are situated upon the southeastern slope of the Santa Fé range of the Rocky Mountains at an altitude of 6,767 feet above the sea-level. They are about forty in number, and vary in temperature from ice-cold to very hot, the thermal springs ranging from 110° F. to 140° F. The following analysis of the waters of the largest of the latter, flowing 1,250 gallons per hour, was made by Dr. Walter L. Haines, professor of chemistry at Rush Medical College, Chicago:

SPRING NO. 6 (LAS VEGAS HOT SPRINGS).

ONE UNITED STATES GALLON CONTAINS:

Solids.	Grains.
Calcium carbonate	0.89
Magnesium carbonate	.15
Sodium carbonate	8.38
Potassium carbonate	.28
Sodium sulphate	3.35
Sodium chloride	14.68
Silica	3.50
Alumina	.10
Volatile and organic matter	.32
Lithium carbonate	Traces.
Sodium bromide	Traces.
Total	31.65

In its chemical composition this water resembles in many respects that of the famous hot springs of Toeplitz, in Austria. The water is conducted to a commodious bath house, where, under supervision of the resident physician, all varieties of baths are administered by a corps of competent assistants. The baths are said to have accomplished excellent results in rheumatism, gout, and diseases of the skin and lymphatic system. Mud baths are a special feature and are used in obstinate or neglected cases. This vicinity partakes in a large degree of the magnificent climatic conditions prevailing in New Mexico. The average humidity of New Mexico, as shown by the recent reports of the United States Signal Service, varies from 29 to 43 per cent. according to locality—as compared with 72 per cent. for New York City, 73 per cent. for New England, 74 per cent. for the Middle Atlantic, and 79 per cent. for the Southern Atlantic States. The climate here is peculiarly adapted to persons afflicted with hay fever, bronchial asthma, and most forms of throat and lung diseases. The rarity of the air, caused by the high elevation, renders this region unfavorable for cardiac affections. Among the many attractions surrounding the Las Vegas Hot Springs may be mentioned the magnificent mountain scenery, the beautiful drives, and the unrivalled opportunities for fishing and hunting. The Montezuma is a first-class hotel, affording comforts and conveniences to meet the most exacting demands. It has accommodations for 250 guests.

James K. Crook.

LATERAL CURVATURE OF THE SPINE; SCOLIOSIS.—The various definitions of lateral curvature fail of their object in so far as they limit themselves to a description of its superficial features and do not emphasize those which are fundamental to the condition. All distortions of the trunk cannot be classified as scoliosis, but only that type of deformity which has for its distinctive feature a permanent asymmetrical distortion of the spine, in rotation and in lateral deviation, resulting in an asymmetry of the two lateral halves of the trunk. Lateral

curvature may therefore be defined as a permanent asymmetrical distortion of the trunk in which the spine plays the fundamental part.

In its initial stages the deformity differs from the various normal positions of the figure only in the origin of these positions and in the permanency of any given one of them. In the more advanced stages the distortions become more pronounced in character, and their permanency or resistance to correction is caused by the alterations in structure consequent upon the adaptive changes which occur during growth.

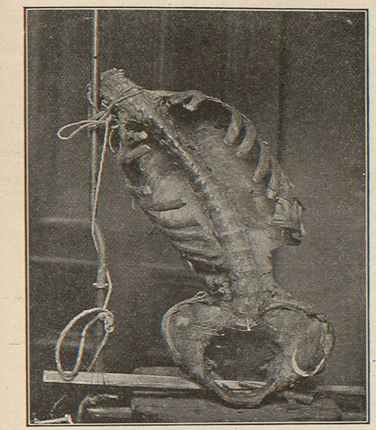

FIG. 3161.—Experiment Showing Lateral Bending.

The movements of the spine which are in a pure antero-posterior plane do not produce asymmetry of the figure since the two halves move symmetrically. The movements of the spine which result in asymmetry proceed from lateral bending and torsion, effecting those changes in figure which would come from a displacement of the symmetrical position of any part of the two halves. The changes which occur in lateral curvature may be classed as, first, the spinal or those affecting the spinal column, which may be designated as primary, and, second, the figure contour changes or those which result from the displacement of the spine, and which, therefore, may be regarded as secondary.

We have already said that these changes, both spinal and contour, which occur in lateral curvature, are, in the initial stages, normal in range and direction but abnormal as to origin and permanency. We will now describe what these changes are; and first, as to range and direction.

The two primary changes which occur, namely, lateral deviation and rotation, are distinct and can be studied separately, although clinically they are always found associated. Since, however, they are not always associated in the same relative degree (whence result the various types of curves), it is better for clearness of description to consider them independently.

Lateral Deviation.—The lateral deviation is the bending to one side of the spine, either throughout its entire length or in a limited section. If lateral deviation could be regarded as a pure movement, all parts of the vertebræ would be carried equally to the side, so that a line drawn through the centre of any of the vertebræ would be in the direct antero-posterior plane of the body. This lateral deviation may affect any portion of the spine and to any degree, or it may affect two different portions of the spine each in a different degree and in a different direction. It resembles lateral bending in that it is a movement in the lateral plane; but differs in that it is a bending of a portion of the spine on itself without necessary displacement of either extremity, whereas lateral bending is a bending of the spine to one side on the pelvis, away from the median plane of the body.

Rotation.—Rotation is a turning on the vertical axis of all the vertebræ participating in the curve; the amount of displacement for each vertebra being different, and being greatest at the middle of the curve. The axis of rotation is in about the posterior third of the vertebra, the movement of the anterior part of the vertebra being in the opposite direction from that of the posterior. The length of the anterior portion in front of the axis of rotation being greater than the posterior, the amount of deviation from the normal of the bodies is necessarily greater than that of the spinous processes. The rotation of the spine necessarily involves those parts of the skeleton which are attached to it, as the ribs, and the result may be seen in the shape of the thorax. If rotation occurred as a distinct movement, the axis of its rotation would then remain in the centre of the trunk, the bodies would describe a curve upon one side and the spinous processes a curve of a smaller arc on the other. This rotation, like the lateral deviation, may affect the whole of the spinal column, or only a portion, or two sections in different directions.

Although these two distortions, rotation and lateral deviation, may be studied independently, it must be remembered that clinically they are always associated. Moreover, they are always associated in the same relation, in that the rotation of the bodies is always toward the same side as the deviation of the column.

FIG. 3162.—Experiment Showing Rotation.

It is necessary to remember, in relation to deviation and rotation, that, since the rotation of the bodies is in the same direction as the deviation of the column, the degree of divergence of the body of any vertebra from the

straight line or midline of the trunk, is the amount of lateral deviation of the column at this point plus the amount of rotation; and the amount of departure of the spinous processes from the midline (since the movement in rotation of the posterior part of the vertebra is in the opposite direction from that of the anterior) is the amount of lateral deviation of the column minus the rotation.

Although these two movements are always associated clinically they are not associated in any definite degree or proportion, and since they may affect any part of the spine to any degree and may be associated in different degrees, there is allowed the widest range of variation in the resulting types of curves.

The Secondary or Contour Changes. — The secondary conditions cannot, like the primary, be studied as distinct and definite distortions, since they consist of the displacement of the parts of the trunk and their very great variety does not admit of a definite enumeration. It is better, therefore, to study these with reference to the direction of displacement of the different parts which may be affected. The trunk may be studied in its lateral plane by the position of the head, including the shape of the neck, by the position of the shoulders and scapulæ, and by the line of the thorax, etc.; and in the horizontal plane by

A. Head and neck (as shown by):
  (*a*) Line of trapezius.
  (*b*) Position of head.
  (*c*) Sterno-mastoid muscle.
B. Shoulders.
  (*a*) Level (vertical plane).
  (*b*) Forward inclination (horizontal plane).
C. Scapulæ.
  (*a*) Level (vertical plane).
  (*b*) Distance from the spine (lateral plane).
  (*c*) Distance from the middle of body (lateral plane).
  (*d*) Prominence (antero-posterior plane).
    (1) Position relative to spine (angle of inclination).
    (2) Position relative to underlying ribs.
D. Line of thorax.
  (*a*) Shape of side of thorax and waist.
  (*b*) Arm-waist angle.
  (*c*) Relation of lower ribs to crest of ilium.
E. Prominence of two sides.
  (*a*) Dorsal region (ribs).
  (*b*) Lumbar region (transverse processes of vertebræ and erector spinæ muscle).

The above description is equally applicable to changes occurring in the normal or in the abnormal condition

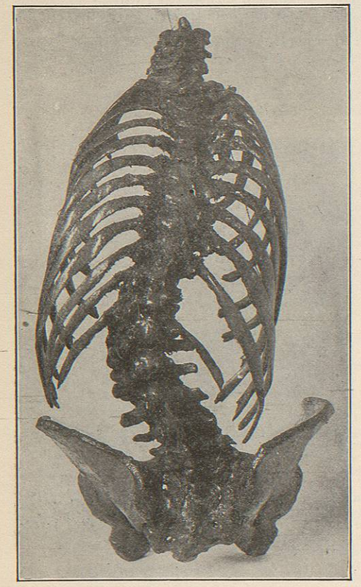

FIG. 3163.—Posterior View of Scoliotic Spine. (Warren Museum.)

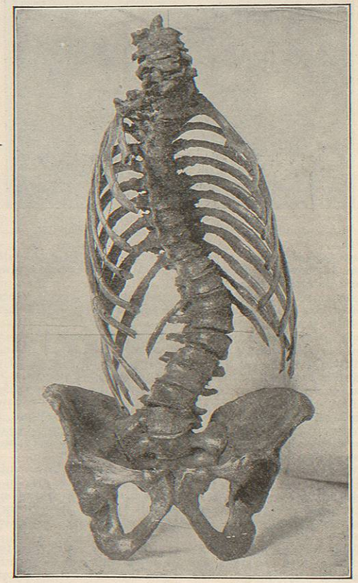

FIG. 3164.—Anterior View of Scoliotic Spine. (Warren Museum.)

the relative prominence of the back at any level, as may be manifested in the dorsal region by the shape and position of the ribs, and in the lumbar by the belly of the erector spinæ muscle. In this way we may map out the method of examining the trunk as follows:

since in the normal the same asymmetrical changes, such as lateral deviation and rotation, may be produced by the usual and ordinary movements of the spine.

A further consideration of the affection called lateral curvature leads us to a study of those conditions which

distinguish it from the normal, viz., its origin and permanency. This permanency is occasioned by the changes in structure which occur particularly in bone, but may also occur in ligaments and muscle, and they are the result of the altered relations of the parts consequent upon the distortions of lateral deviation and rotation. Since these changes occur during the formative period of growth and conform to those malpositions of the spine which are constantly assumed, they illustrate the law that, during growth, structures adapt themselves in shape to positions in which they are held.

These structural changes may be considered as they are seen in the bones, the ligaments, and the muscles.

Changes in bone are seen in the thickness of the bodies of the vertebræ, these being wedge-shaped instead of having an even thickness; there is also a twist in the antero-posterior axis, so that a straight line drawn through the vertebra does not intersect it into two equal halves. Accompanying these changes in the vertebræ are alterations in the shape of the ribs, consisting of an increase of the angle behind on the side of rotation, and a flattening of the corresponding portion on the opposite side, with an increase in prominence in front, so that the long diameter of the chest is oblique instead of lateral.

Accompanying these changes in the shape of the bony parts of the trunk are the adaptive changes in the length of ligaments, which become shorter on the concave, and longer on the convex sides, thus serving to hold the spine in this position. It is also to be remembered that after long continuance in malpositions there are adaptive changes in the length of the muscles.

ETIOLOGY.—Many theories have been advanced from time to time in reference to the etiology of this condition, no one of which is sufficient, and yet each is of value in that it suggests some of the conditions which are active either in the initiation or in the increase of the curve already developed, and a mention of some of these is of importance to show the stages through which this part of the subject has passed. One of the theories was that of unequal growth of bone, advanced by Hueter and Engell, who based their views on the distortion in the vertebræ found post mortem, but which is now known to be a result of growth while the spine is in a false position. Another, advanced by Guérin, was that the distortion was due to a spasmodic muscular action. Tenotomy and myotomy on the concave side have been performed for this, the shortening and contraction of the muscles being mistaken for muscular spasm. Eulenberg upheld the theory of muscular action, but regarded it as an unequal action due rather to weakness than to spasm, believing that, as muscular action is necessary to keep the body erect, if it is defective in one direction, distortion will occur. Although a weakened muscular tone undoubtedly plays a very influential part in some cases, yet in the vast majority unilateral weakness cannot be proved to exist.

Another theory was that of the superincumbent weight, and this theory, urged by Rosa and Volkmann, received much support. It was based on the supposition that the weight of the superimposed parts falling upon the supporting vertebræ, exerted a force which caused the rotation and deviation of the spinal column. Undoubtedly this is a most powerful factor when a curve is once established, but experiments have shown that superincumbent weight placed upon the normal spine does not cause rotation until the spine has already been forced out of position. Moreover, this affection is found in the horizontal vertebrate animals in whom there can be no superincumbent weight upon the spine, and it is also not especially prevalent among the races who are accustomed to carrying weights upon the head. Therefore, this condition cannot be regarded as due to any one factor having a specific action on the spine, but rather as the result of the combined influence of many conditions acting more or less continuously or frequently.

Lateral curvature is a vice of development, and a study of the etiology is the study of the influential factors which result in the development of the asymmetrical instead of the symmetrical form. It is a well-recognized fact that bone, during the period of growth, or in certain pathological states, may be moulded into various unusual shapes by pressure; and therefore if we have, as in

FIG. 3165.—Lateral Curvature after Empyema.

lateral curvature, a condition of plastic bone coupled with a position of distortion of the spine and appendages, either constantly or so frequently assumed as to exert an unequal pressure upon the vertebræ, we have conditions which may result in asymmetrical growth and the formation of a permanent deformity.

Recognizing the fact that one of the essential factors in the development of lateral curvature is the presence of plastic structures, the further consideration of the etiology of this deformity is the study of the conditions which result in the assumption and maintenance of any one malposition by the individual.

The factors which bring about malpositions may be divided into (1) those in which there is a physical defect as an apparent cause, and (2) those in which there is no sufficient physical defect, the deformity resulting rather from many conditions of environment which tend to promote bad attitudes. When the habit of malposture is once established, the factors of muscular weakness and superincumbent weight have a tendency toward exaggerating the condition.

These etiological conditions may be tabulated as follows: 1. Physical defects, such as (*a*) paralysis, (*b*) loss of limb, (*c*) empyema, (*d*) torticollis, (*e*) static defects, (*f*) defective vision, etc. 2. Habits of posture as influenced by (*a*) occupation or recreation, (*b*) general environment (school desks, etc.), (*c*) effect of clothing,

etc. 3. Muscular weakness, and 4. Superincumbent weight, when combined with the above-enumerated conditions.

Among the physical defects may be mentioned those of loss of arm, causing unequal distribution of weight; tho-

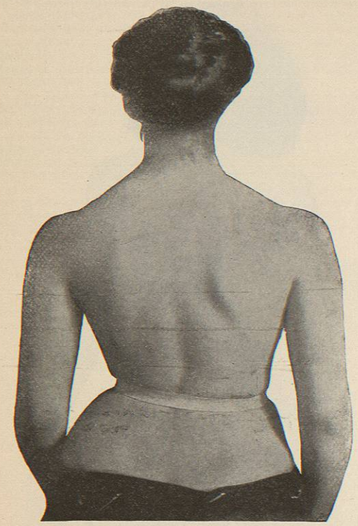

FIG. 3166.—Showing the Effect of a Belt on a Slight Curve.

racic disease, as empyema, with incomplete lung expansion, resulting in the unequal development of the two sides of the thorax; static condition, as short leg, giving unequal pelvis; paralysis, giving unequal muscular support, etc.

Among habits of posture are such as standing on one foot, standing or sitting in one position, exercise in a constantly bad position, continued use of one arm, etc. As an illustration of faulty environment may be mentioned the improper arrangement of clothing, making undue pressure upon one or the other shoulder, position of the child's desk with reference to the teacher, improperly constructed school seats, etc.

In the conditions of health and muscular tonicity one finds the habit of malposition much less frequent than in the condition of muscular tire and muscular weakness. It is not to be expected that a young and growing child shall always preserve a correct posture, but, on the other hand, a child does not habitually assume any one particular bad posture without some cause, and so for this reason the factor of muscular weakness becomes etiologically important when combined with those conditions which induce malpostures.

In the same way the factor of superincumbent weight acting upon a spine already in a position of deviation and rotation, furnishes a powerful additional force to the increase of the distortion already established.

The etiology can, therefore, be graphically represented in the following diagram:

Physical defect. Habits of position. Growing periods. (Plastic stage.)	Faulty attitudes.	Lateral curvature.
Abnormal bone. (Rickets.)	Soft bone.	

Classification.—A convenient classification of these cases is based upon the stage of their development, since the process is a continuous one and the case represents like conditions in all the phases of its course, showing a difference only in the degree of severity. The record of the case gives the location and character of the distortion, and it is not necessary, therefore, to resort to an arbitrary classification in order to define the location of the deformity. Although this division into stages must be more or less arbitrary, since the condition is progressive, yet it enables one to record in general how much of a change has taken place, and is of value as an indication for treatment as well as in the prognosis.

We may therefore divide lateral curvature into three stages: 1. The postural, in which the curves are flexible and there is no evidence of osseous change; 2. The structural, in which the curves are flexible but in which there is an evident osseous change; 3. The fixed curves of marked severity, in which there is little or no flexibility.

The conditions found in the different groups are: 1. Postural; showing (*a*) slight changes in contour, (*b*) slight degrees of lateral deviation and rotation, (*c*) easy correc-

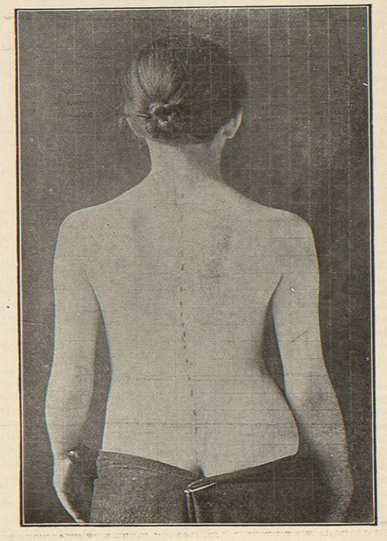

FIG. 3167.—Showing the Condition in a Postural Case of Lateral Curvature of the Spine.

tion or over-correction, (*d*) asymmetry in flexibility. 2. Structural; (*a*) pronounced changes in contour outline, (*b*) permanent lateral deviation and rotation of the spine, (*c*) correction and over-correction not possible, (*d*) evidence of bone changes. 3. Fixed; (*a*) marked contour changes,

(*b*) extreme degrees of lateral deviation and rotation, (*c*) correction not possible, (*d*) evidences of extreme bone changes, (*e*) inflexibility.

Age of Appearance.—Congenital cases have been reported. They are, however, so very rare that they are

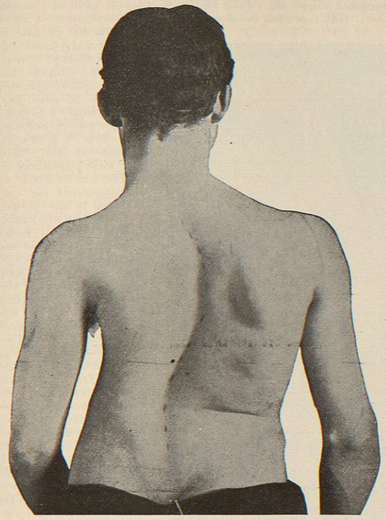

FIG. 3168.—Showing the Condition in a Structural Case of Lateral Curvature of the Spine.

accounted more as curiosities than of importance, and are usually associated with ante-natal rickets, or else with some other congenital defect, such as the absence of ribs or other general malformations. A certain number of instances are brought to the physician's notice in infants of the age of a few months. In the majority of these cases it is found that the deformity is caused by holding or carrying the child in one position, so that it is practically moulded into this shape. As an instance of this may be mentioned the case of an infant of six months, with a distinct lateral curve, which was apparently caused by keeping the child during the greater part of the day propped in the corner of a sofa, the curve of the spine fitting the position it assumed while in this place.

In the majority of instances the cases are brought to notice during the period of rapid growth. Different statistics which have been collected with reference to the time of appearance apparently group themselves into two periods, that of the first growth, about the age of eight or nine, and that of the second, between the ages of eleven and fifteen, depending somewhat upon the sex. Undoubtedly many of the cases really date from a time previous to their discovery, but since an increase is more likely to occur at a time when the structures are in the most plastic condition, and at a time when the strength of the child is taxed by the process of growth, it is natural that the affection should be first recognized at such time. One may look for the rapid development of the curves during these times of growth, and for a decrease in the rapidity of their progress after the period of growth is over and the bones have become hard.

Influence of Sex.—By far the largest number of cases are found in girls, and this is undoubtedly due to their more restricted environment, to their less general participation in athletic exercises, and to their weaker muscular condition. The deformity is often seen, however, in robust boys, frequently among those who are devoted to a special form of athletics, and such cases often develop to an unusual degree of severity.

SYMPTOMS.—The subjective symptoms in this affection are, as a rule, slight, and more frequently there are none. They are sometimes seen in the severer cases in which the unequal distribution of weight would seem to play a factor, giving a greater muscle strain and muscle tire. When present they usually consist of easy fatigue and irritability, and are such as would ordinarily accompany a general muscular insufficiency, rather than a particular spinal lesion. At times, however, in cases with very marked deformity, pain referred to the concave side is a troublesome feature.

Record.—In the recording of lateral curvature there are two features to bear in mind, first, the changes in the contour of the figure caused by relative displacement of parts, and second, the changes which are seen in the spine and the bony framework of the trunk. It is best to keep this distinction in mind, since in the one we need only graphic reproduction to show the character and general amount of such change, while in the other we must take as accurate measurements as possible to show the amount of departure from the normal. Records may be taken in

FIG. 3169.—Showing the Condition in a Severe Fixed Case of Paralytic Origin.

either the standing or the lying position, each having its advantages, and each being of value both for itself and for comparison with the other.

The upright position, in that it is the usual position and represents the greatest curve, gives the more practical record. On the other hand, the conditions in standing