THE USE OF THE CONDITIONED RESPONSE IN BRACING*

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The purposeful use of the conditioned response as a corrective force in bracing was first used in the back-knee brace described in 1954 in the Journal of Bone and Joint Surgery(3). This particular brace was so designed that as the knee went into the undesirable back-knee position, the skin of the popliteal area touched a pin, thus reflexly causing the knee to be drawn away from it. The patient thus became conditioned to holding the knee straight rather than in a back-knee position.

So successful has been this new function of a brace that we have since then designed and used other braces which employ this same conditioned response mechanism in the correction of other types of deformities and undesirable muscle habits.

The results have been good, far better than have been obtained with braces constructed along conventional patterns where pressure was the basic corrective force.

Those additional conditions for which we have designed and used conditioned response braces are:

1. Round back-sway back postural abnormality, Figure one.
2. Neck flexion-round back postural abnormality, Figure two.
3. Scoliosis, Figure three.

The following comments, case histories and illustrations should enable you to order, have built, and use, these or similar braces employing this conditioned response mechanism.

* The subject matter of this article was presented as a scientific exhibit at the 1956 meeting of the American Academy of Orthopaedic Surgeons in Chicago.

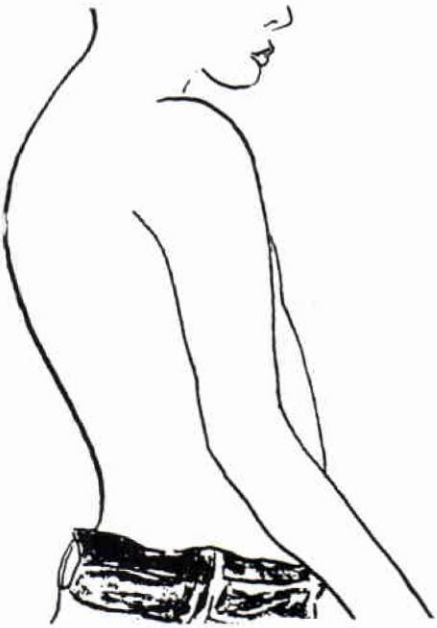

Fig. 1: Usual type of habitual round back-sway back postural abnormality.

Round Back-Sway Back Postural Abnormality

The usual treatment program of today for this condition, Figure one, consists of:

1. Specific exercises for development of the strength of the abdominal and gluteus maximus muscles.

2. Application of a brace which by three point pressure attempts to hold the low back flat.

3. Instructing the patient to "stand tall", to flatten the stomach, to stand correctly, and *to do it so much that it becomes habitual.*

Strong, tense gluteus maximus and abdominal muscles, particularly the latter, rotate the pelvis upright and correct the abnormal lumbar lordosis, Figure four. When this occurs the thoracic spine compensatorily straightens, the shoulders naturally fall backward instead of forward and the posture becomes normal. All of this is true if this abnormality is due to a habit and there is no associated fixed structural deformity such as occurs in kyphosis dorsalis juvenalis.

This regimen of treatment is successful if the patient is young and his spine is a growing one, and if he follows directions implicitly, and constantly, particularly number three.

It is not often though that a patient accurately and assiduously carries out these instructions and *seldom indeed does he ever develop the habit* of standing and walking correctly with his abdominals tight, hence improvement occurs slowly and often not at all.

It was for this type of patient that we devised the brace as in Figure five. The two pins in the abdominal pad prick the skin of the abdomen whenever the patient relaxes his abdominal muscles thus causing him reflexly to tighten them. As he does this thousands of times a day two things happen. The abdominals increase in strength and *he acquires the habit of holding them in.*

This type of brace has been used on eight patients who have obtained satisfactory correction and we have on each of them discarded the brace. Three others are now wearing this type of brace and we are pleased with their progress.

Illustrative Case Report

J. M., age twelve. This patient's sway back-round back postural abnormality had been noticed for about three years. He had been given exercises to do by his doctor which he did occasionally in a lackadaisical fashion. He was not improving.

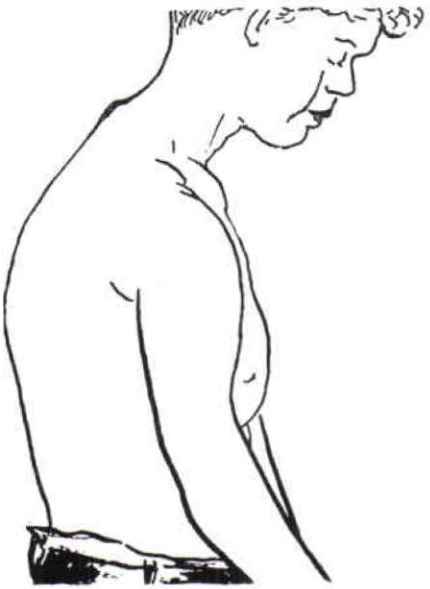

Fig. 2: Neck flexion-round back postural abnormality. The low back is normal.

The conditioned response brace was applied sixteen months ago. He wore the brace all day every day. Ten months ago, I removed the brace and told the parents to reapply it if they noticed his deformity recurring. I have been seeing him at intervals of every two months since then. He has not re-acquired his old postural habit.

Neck Flexion-Round Back Postural Abnormality

In this type of postural abnormality, Figure two, the low back posture is relatively normal. A sway back does not exist. The main deformity is a forward flexed head and neck, and a moderately rounded thoracic spine. This usually is seen in tall children who stand head and shoulder above their classmates and who, because of this, try to lean down to the level of the others. They do this so much that it becomes habitual.

The patient can correct this easily by simply holding his head up and his chin back, "West Point" style, but

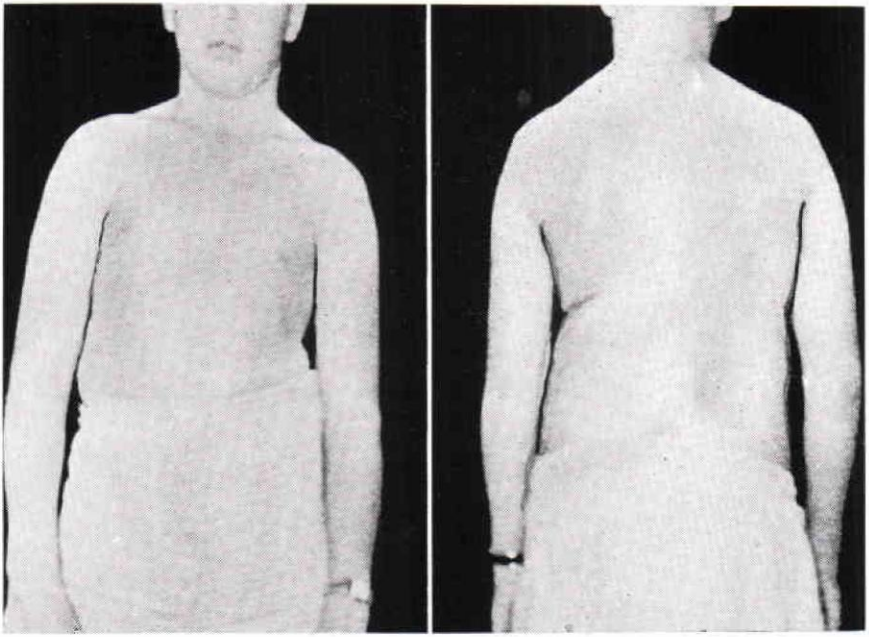

Fig. 3: Moderate degree of fixed idiopathic scoliosis in a thirteen year old boy.

because of his height he continues to lean down habitually and it is difficult to train him out of it.

For this type of patient we have constructed and applied the neck brace illustrated in Figure six.

When the head and neck lean forward too much, the skin on the front of the neck touches the sharp tip of a pin, thus causing the patient reflexly to straighten up. As he does this repeatedly thousands of times each day, he acquires the habit of holding the head erect.

This has been used on three patients with excellent results.

Illustrative Case Report

E. F., age fourteen. This tall, slender boy had been stoop-shouldered for over two years according to the parents. He has had no treatment, but the parents, and often his teacher, constantly have reminded him so stand straight, to hold his head up. Each time that he is so reminded he does straighten up, but only momentarily and he was not improving.

I saw him first fourteen months ago. The conditioned reflex neck brace was applied. He wore it all day every day. Within two months' time his habit apparently was broken and the brace was removed. However, two months later he again had re-acquired his old habit and the brace was reapplied. He wore it this time for three months, it was removed and during the last six or seven months he has not relapsed into his old postural habit.

Scoliosis

Scoliosis in its early stage, or of a mild or moderate degree, Figure three, is usually treated by specific torso muscle exercises and a back support such as a cast or a brace.

The purpose of the specific body muscle exercises, Figure seven, is to develop such a degree of strength in certain of those muscle groups that they, by their increased strength and endurance, can hold the spine either straight, or in a state of dynamic balance, the latter being accomplished

by the development of a compensatory opposite curve above or below the primary curve, thus converting an undesirable C curve into the more stable, balanced S curve.

These specific muscle exercises for such a curve are carried out ordinarily by the most conscientious patient one or two hours a day at the most, and the other twenty-two or twenty-three hours of the day the deforming forces, muscles, gravity, and sometimes abnormal bone growth have full play; thus correction occurs from this source slowly indeed and in most instances not at all.

When a cast or a brace is applied, it is one which by mechanical pressure attempts to hold the spine straight.

While this brace may hold the spine corrected or partially so, it is pernicious in its ultimate effect because the patient learns to depend on it for support; his torso muscles weaken rather than gain in strength, the curve increases as growth of the spine occurs and eventually a turnbuckle cast and a fusion become necessary.

In the early stages of most moderate or mild degrees of scoliosis in which fixation has not become pronounced, a patient can stand leaning to one side (the side of the convexity) in such a way as to partially or completely correct and in some instances to overcorrect the primary curve. Particularly is this true if the patient stands with all of his weight on the leg of the convex side, his opposite knee being bent and the pelvis tilted down on this side. Figure eight.

If we can do these following three things we shall increase the efficiency of our non-surgical corrective program in these scolioses.

1. If we can eliminate the muscle weakening effects of a confining pressure type of cast or brace and yet maintain the spine in a corrected position night and day for a sufficiently long period of time.
2. If we can make the patient exercise those particular specific torso muscles all day long and at night too, instead of for just one or two short intervals a day.
3. If we can habituate the patient to bending slightly sideways in the desired direction regardless of whether he stands, sits or lies down, and at the same time to stand habitually whenever he stands still, on the leg of the convex of the curve.

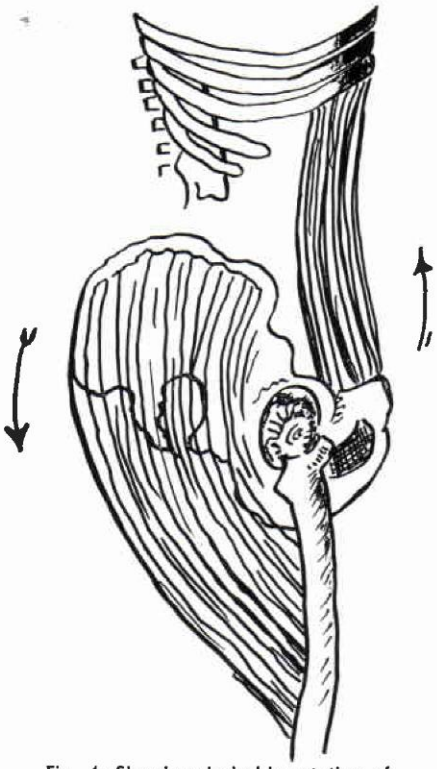

Fig. 4: Showing desirable rotation effect on pelvis, produced by strong, tense gluteus maximus and abdominals, especially the latter, thus correcting the sway back.

If these things are done efficiently and for long enough and if the spine is a growing one, then considerable correction should occur in almost all

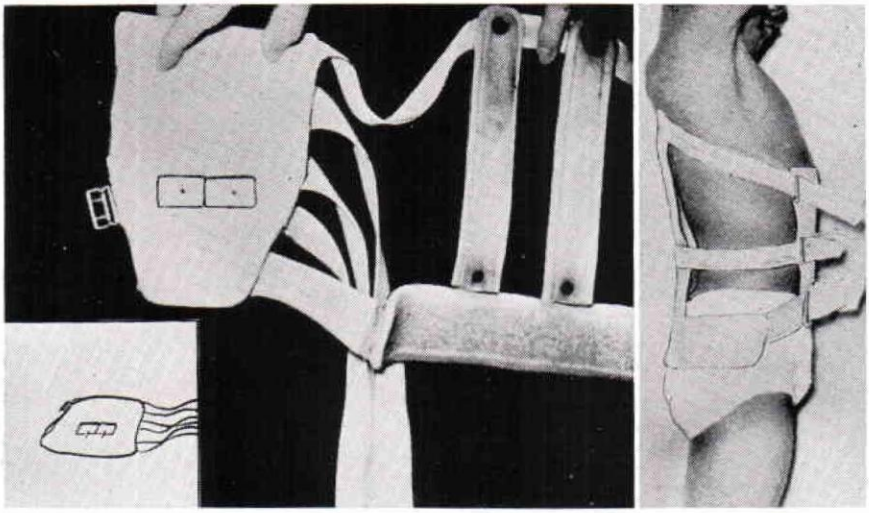

Fig. 5: Conditioned response brace for correction of sway back-round back postural abnormality. Pins in insert showed longer than necessary for clarity.

of them, since *growing things tend to grow in the way they are held.*

With this in mind we developed the scoliosis harness-brace, Figure nine, which works on the conditioned response principle and which does accomplish every one of the three desired things mentioned above.

It does hold the spine in a corrected or over-corrected position night and day, since it is worn at night as well as all day. It does not do so by mechanical pressure or confinement and wearing it does not weaken any of the body or extremity muscles.

It does make the patient reflexly exercise the specific lateral torso muscles on the desired side and he does this exercise literally thousands of times each day and night, thus they gain in strength much more completely and much more rapidly.

It does habituate the patient to standing constantly, when he stands still, with all his weight on the leg of the convex side of the primary curve, his opposite knee bent and his pelvis slumped downward on that side. It also induces him constantly to lean slightly sideways, to the side of the convexity of the primary curve, regardless of whether he stands, sits, or lies down.

This harness is not heavy, cumbersome, bulky, is not particularly uncomfortable to wear and it does not slow down in the least, the patient's routine activities of the day.

How Scoliosos-Harness Works

The side strap, Figure nine-B, should be tight enough to hold the spine bent slightly sideways, to the side of the convexity of the primary curve. This alone though is not enough. It is the natural inclination of everyone to pull against or resist any restraint and if the patient does this with the harness-brace or any other kind of side bending brace, he will exercise the wrong group of muscles. He exercises, in pulling *against* the harness-brace, the lateral torso muscles on the concave side of his primary curve which is highly undesirable and which defeats the purpose of the harness. For this reason then the felt-pin device is affixed to the inner (skin) surface of the side strap. It is so placed that if the patient straightens up or leans the wrong way, or if he stands with all of his weight on the wrong leg the side strap is pulled against his body and the pin touches the skin of the side of his

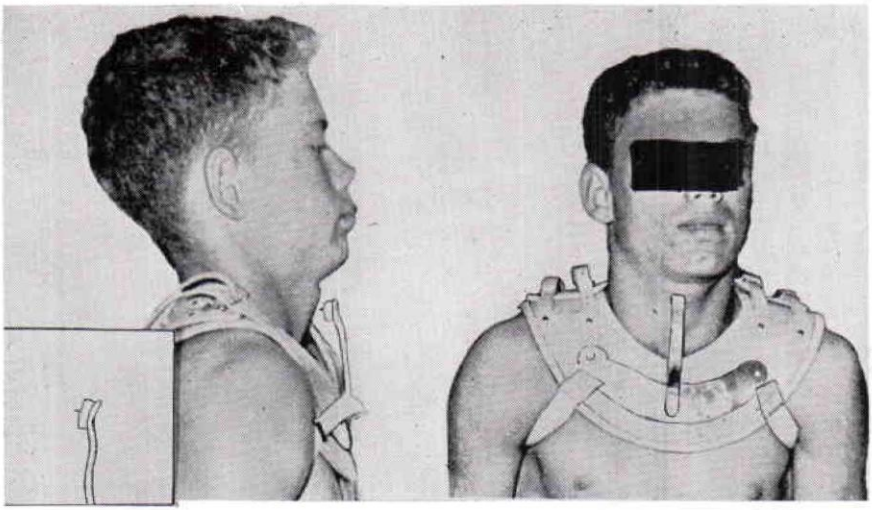

Fig. 6: Conditioned response neck brace used for correction of neck flexion-round back postural abnormality. Insert shows felt-pin device affixed to upright strip.

body causing him thereby reflexly to assume the desired position. Thus all day long, and all night too, he reflexly leans or holds his body in such an attitude as to hold the spine corrected.

Furthermore, thousands of times each day as the skin touches the pin the patient's torso muscles on the convex side of the curve reflexly contract to pull the body away from the pin, Figure ten, thus exerting a positive dynamic corrective force on the curve by exercising those specific muscles, the very ones which by their increased strength and holding power maintain the spine in a straight or a balanced position.

There is nothing new in this underlying theory of treatment as presented here. Specific exercises and a harness brace[1] have been used at times past for scoliosis, and the development of a compensatory curve in the opposite direction to the main primary curve is one of the fundamental concepts of spine balance and has been so recognized for many years.

What is new is the method of doing this by the use of this conditioned response mechanism on the scoliosis harness. Instead of specific muscle exercises carried out voluntarily at stated intervals, the patient reflexly does them all day long, and even at night should he relax into such a position as to increase the primary curve then the pin touches the skin of the side of his body on the convex side of the curve and he reflexly corrects it even while asleep. He becomes conditioned therefore, to holding the spine in the corrected or correcting position and in the process of conditioning him, a marked increase in the strength of the particular muscles necessary for maintaining spine balance occurs.

Figure eleven shows the x-ray of the same patient's spine as in Figure eight, but standing with the scoliosis harness-brace on and with all weight on the right leg. Note the increased degree of correction with the scoliosis harness on, due to the almost constant reflex contraction of the right torso muscles.

Contra-Indications

The scoliosis harness is of little or no value in the fixed, advanced degree of roto-scoliosis. It has not been very successful in stopping the prog-

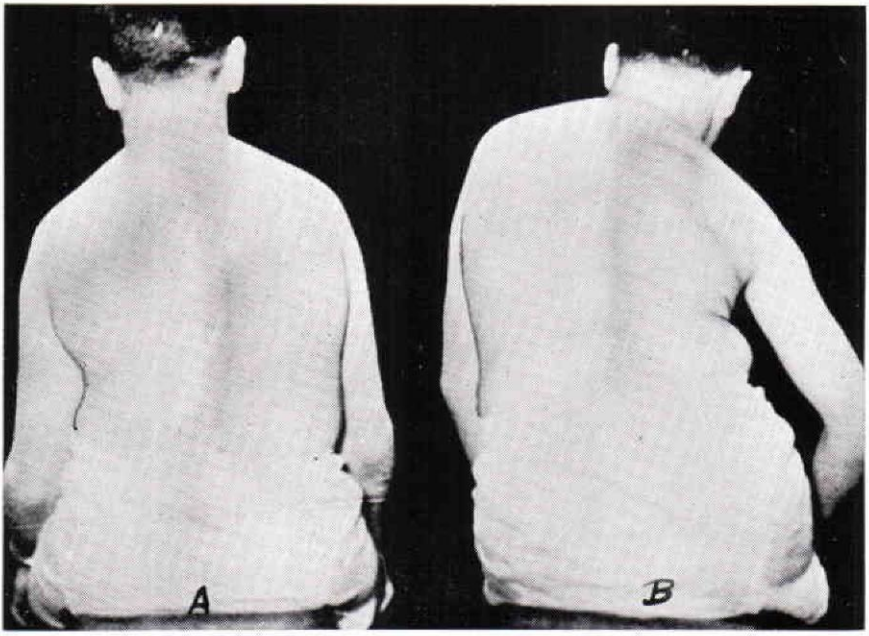

Fig. 7: a. Scoliosis patient sitting normally
b. Same patient holding right torso muscles tight in doing his specific muscle exercise.

ress of the high thoracic primary curve. Adults apparently don't tolerate it very well, mainly because the adult is interested in pain relief rather than correction of the curve. In some post-polio cases where a hip flexion or other contracture exists or where a marked amount of torso muscle weakness or leg weakness is present, it will not be of much value. I have not yet used it in children below the age of five so I don't know for sure whether it works well in that age group or not.

I have not used it on Cerebral Palsy patients, and I do not anticipate using it on them, because in most instances the Cerebral Palsy child does not have sufficient control over his muscles to enable him to obey the withdrawal reflex induced by the skin touching the pin.

Indicated In

Its greatest value lies in the treatment of early, mild, or moderate degrees of lumbo-thoracic curvature, some of which are purely static scolioses, and some of which are beginning to acquire a minimal or moderate degree of fixation and rotation. Many of those straighten out completely and those that do not, do develop satisfactory dynamic balance by the formation of a well balanced S curve.

This method of treatment, using the conditioned response principle of the scoliosis harness as a correcting force, has been used on sixty-eight patients with extremely gratifying results.

Illustrative Case Report

C. P., age thirteen, Male-Idiopathic scoliosis—Figure three.

This boy was seen first on December 28, 1954, because of his spine. The conditional response scoliosis harness-brace and a one-inch right heel elevation was applied on that day. He was seen one week later, then a month later, and again the last time on March 22, 1955, which is three months since the harness was

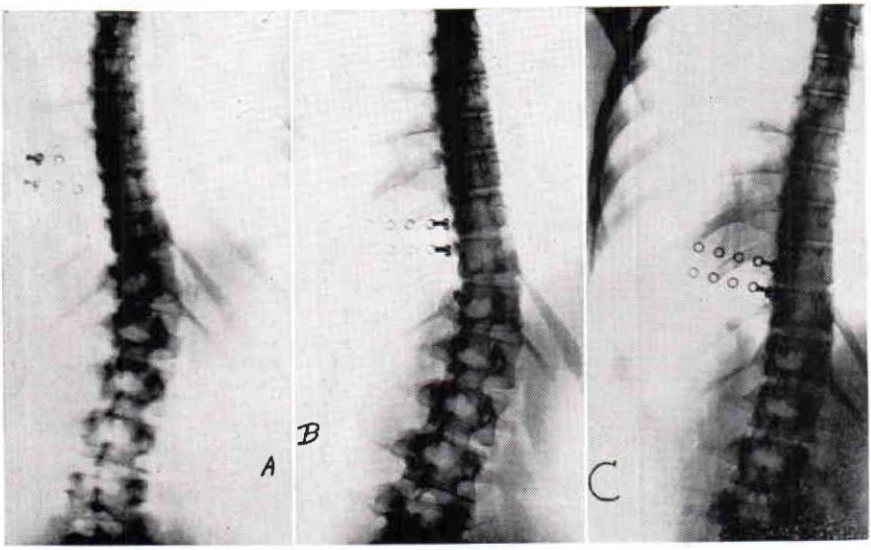

Fig. 8: X-rays of a post-polio scoliotic spine, age fifteen
a. lying down
b. standing, weight equal on both legs, no elevation on either heel
c. standing, all weight on right leg and leaning to right

applied. Figure twelve shows the spine at the initial examination. Figure thirteen shows it at the last examination. He has worn the harness night and day. It does not interfere with his sleep or his daily activities. When he plays tennis he covers the pin to prevent its sticking him, but all the rest of the time he wears it faithfully, as we requested.

Since this boy is in a stage of rapid spinal growth it is our present intention to have him continue to wear it for another year or two. It seems highly improbable that he will ever need a turnbuckle cast and a fusion.

Brace Construction

The brace used for correction of the round back-sway back abnormality may be made just exactly like almost any other low back brace. The one thing which makes it different and which converts it into a conditioned response brace is the addition of two pins on the inner surface of the abdominal pad. Figure five. This is done by cementing two small squares of felt to the inner surface of the abdominal pad and placing in the center of each of them a short pin, tack or flat headed shoe nail, the point of which protrudes about one millimeter beyond the felt surface, just barely enough to prick the skin of the abdomen if the abdominal muscles are not kept tight and retracted.

If a flat headed shoe nail is used, the point must be sharpened on an emory wheel. The sharper the point, the better it will work. If only one pin is used, the tip of the pin may lie in the umbilicus, and the patient will not feel the pricking sensation, hence two pins must be used. Furthermore, they must not be placed too high so that the pressure of the belt around the waist will cause it to be constantly in contact with the body. Also, it must not be placed too low near the symphysis pubis because then the patient cannot withdrew away from it. It should be placed on either side of the midline at the most prominent lower portion of the abdomen.

The neck brace, Figure six, used in

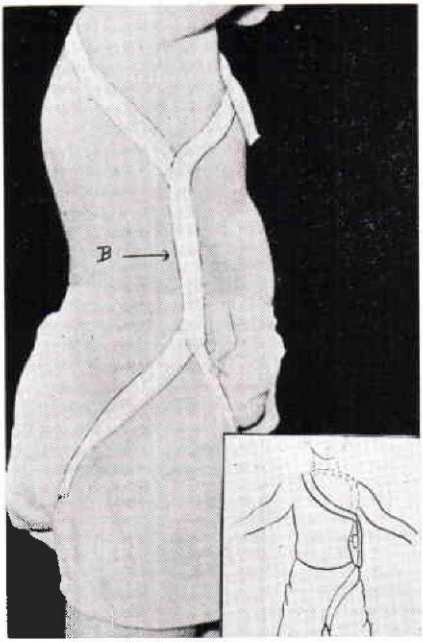

Fig. 9: showing conditioned response scoliosis harness-brace. Insert—felt-pin device exaggerated in size for clarity.

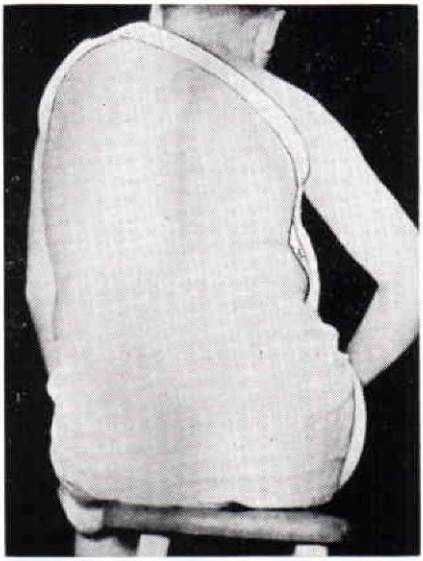

Fig. 10: Same patient as in Fig. 7, but wearing scoliosis harness. Note how he habitually sits with right torso muscles contracted to prevent pin from sticking skin of right side of chest. He stands and lies down the same way.

the neck flexion-round back postural abnormality is simply a flat leather collar resting on the shoulders about the base of the neck with an aluminum plate in front, to which is attached a small vertical aluminum strip and on the side of this upright strip which faces the neck, the felt-pin device is affixed. This upright aluminum strip is so adjusted that if the patient's neck goes forward into the undesirable position, the skin of his neck touches the pin, and he reflexly straightens up the head and neck.

The scoliosis harness is made of one-inch webbelt. The side strap is sometimes most effective when made of a strip of woven elastic, but in most instances it is made of the same inelastic web belting as the rest of the harness. It is, of course, always placed on the convex side of the primary curve. The square of felt and pin are placed on the side strap in such a way, and in such a position, as to touch the most prominent fold of skin on the side of the chest or loin if the patient straightens up, leans to the opposite side or stands on the wrong leg, but it must not touch if he sits, stands, or lies down correctly.

When a patient sits for a long period of time the side strap may migrate forward some, and cause the pin to touch the antero-lateral aspect of the body instead of the true lateral aspect. If it doesn't migrate around to the true frontal plane of the body, it is all right. I have simply found from experience that it works just as good on the antero-lateral as well as the lateral aspect. The patient can be instructed to pull it back to the true lateral aspect and this is usually sufficient.

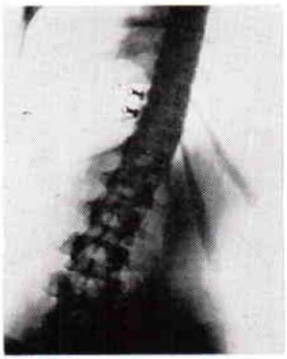

Fig. 11: Same patient's spine x-rays as in Fig 8, but now wearing scoliosis harness. Note additional correction due to habitual reflex contraction of right lateral torso muscles.

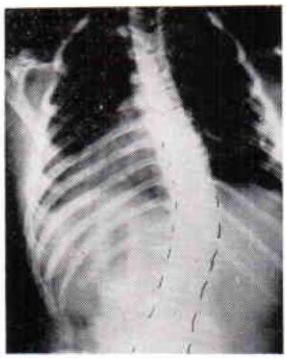

Fig. 12: Spine at initial examination. Film made with patient standing, weight equal on both feet, knees straght. This is the x-ray of patient in Fig. 3, idiopathic scoliosis.

Fig. 13: Same patient as Fig. 12, standing, weight equal, knees straight, but now wearing scoliosis harness-brace and a one-inch lift on right heel. This film made three months after application of harness. Note straightening of primary curve and development of a curve in opposite direction.

Dr. Herbert E. Hipps is a fifty-three year old orthopedic surgeon living in Waco, Texas. He got most of his orthopedic training under Dr. W. B. Carroll at the Scottish Rite Hospital for Crippled Children in Dallas back in 1931, 1932 and 1933, following which he studied in Europe for eight or nine months, before starting in al private practice in Texas. He is the author of some thirty-five or forty various articles on various orthopedic subjects. Dr. Hipps is, at the present time, a Diplomate of the American Board of Orthopaedic Surgeons, a member of the American Academy of Orthopaedic Sugeons, a member of the Texas Orthopedic Association, and other medical and surgical societies.

Final Comment

The use of the conditioned response mechanism on suitable braces adds materially to the corrective forces necessary for correction of the existing deformity or abnormal muscle habit.

Correction occurs through physiological means rather than by mechanical pressure. It induces the patient to participate actively and constantly in the correction and he thus becomes conditioned to maintaining himself in the corrected or correcting position. He develops the habit of doing so.

It is a thoroughly harmless procedure. At no time have we ever seen any but the mildest skin irritation where the pin intermittently touches the skin.

It is hoped that others will use this most efficient corrective mechanism on these types of braces and also develop new uses for it on other braces and other conditions.

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