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Understanding Scoliosis

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Scoliosis is a *deformity*, not a disease. The cause of the deformity is totally unknown, and in about 60 per cent of cases the child is in all other respects healthy at the time of the development of the abnormal curve. In the remaining 40 per cent of cases, other factors such as congenital malformations (about 17,5 per cent), paralytic lesions (about 15 per cent), and Von Recklinghausen's neurofibromatosis (about 3,5 per cent), are concomitant diseases. The manner in which they operate in producing a curved spine is not always clear.

A turning point in the management of scoliosis came when the **natural history of the untreated curvature** was recorded by James (1954), who conducted a follow-up study of two hundred and forty-one mature cases of idiopathic scoliosis, and of sixty-seven cases in which skeletal maturity had not yet been attained. The disastrous results of the untreated deformities were no longer in doubt, and the vital need for early diagnosis was clear. **In every instance there had been a stage in which the deformity was mild and at which effective treatment could have been easily rendered.** The salient features which enable early recognition have been described by the author elsewhere (Dommisse, 1970).

John Cobb (1948), described an 'outline for the study of scoliosis', and a method for measuring the curve (Fig. 1), which he attributed to Ferguson. The method enjoys universal use and has added immeasurably to the study of the problem. It affords an easily comprehensible index of progress, and of the results of treatment as well as of the prognosis in the individual case.

Attempts at operative correction achieved little success until 1931, when Hibbs, Risser and Ferguson described a technique of posterior spinal fusion which today still forms the foundation on which surgical treatment is based.

The next major step was by Harrington (1962) who introduced a system of instrumentation which not only permitted instant correction of the deformity, but also provided a surgical implant which acted as an internal splint. When combined with Hibbs' posterior fusion, the Harrington method of operative treatment became the standard method of surgical approach.

In spite of more recent surgical advances which include the anterior approach of Dwyer & Schafer (1974), the backbone of treatment remains non-operative. It is by conservative measures only that a return to normal may be anticipated, and it is only in the case of early diagnosis that conservative

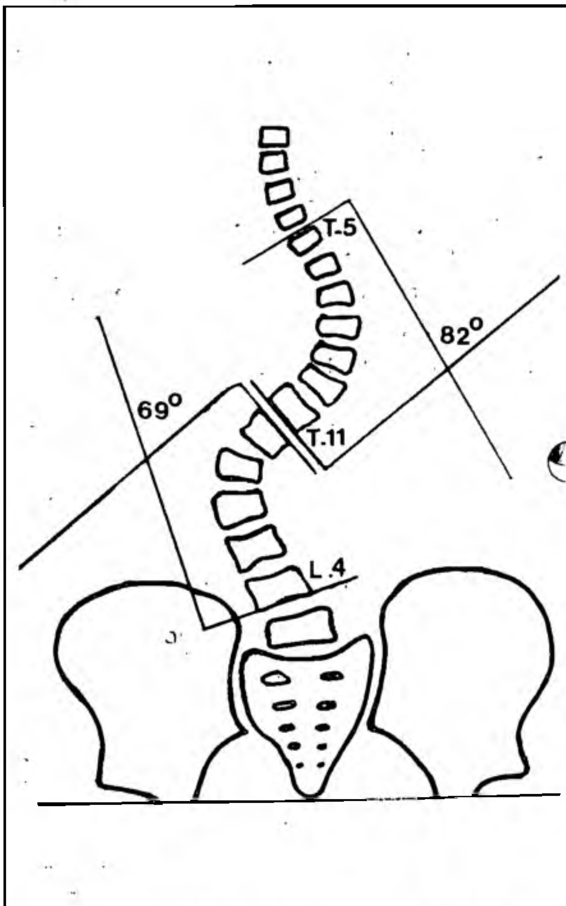

Fig. 1: Measurement of the curves in scoliosis, after the method of Ferguson, as described by Cobb (1948).

measures offer a prognosis which is good. The routine scanning of children during their tender years at school is mandatory, and in some regions is already being applied.

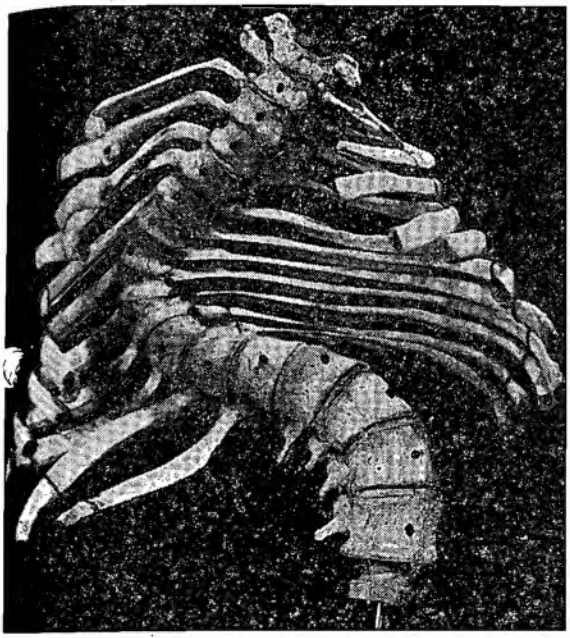

Fig. 2: THE STRUCTURAL CURVES IN THE MACERATED SPINE OF A SEVERE THORACIC SCOLIOSIS. (Photograph by courtesy of the publishers. Messrs. E. & S. LIVINGSTONE LTD., LONDON, M67, and of the author. REFERENCE: Monograph entitled 'SCOLIOSIS'. AUTHOR: J. I. P. JAMES. (Note: The black marker dots have been added by the present author.)

THE NATURE OF THE BASIC DEFORMITY:

The structural curve in the macerated spine (Fig. 2), illustrates graphically the distortion of the bony cage of the chest and also of the abdominal cavity. It needs little imagination to appreciate the degree to which the viscera are compressed.

The complicated nature of the 3-dimensional curves is apparent, and a clear understanding of each component of the deformity is essential to an appreciation of the problem. In the first instance, the lateral bend is most obvious, and it constitutes a physical mal-alignment of the spine. There is a translation of the vertebrae in the curve, away from the middle line of the trunk. The occipital protruberance, which in the normal erect posture is placed directly over the middle of the sacrum, is displaced towards the side of the convexity of the major curve. The intervertebral discs are no longer horizontally aligned, but are oblique in varying degree. The force of gravity which is directed vertically when the individual stands erect, exerts a shearing force on the discs which is harmful and which leads to degenerative changes. In a nutshell, there is a state of disequilibrium in the scoliotic spine, which is quite contrary to nature, and which results in physical spinal disability.

There is a second component which is an integral part of the curve, namely rotation of the vertebral bodies on a vertical axis. Consider the thoracic curve (Fig. 2), and observe the position of the black dot placed at the middle point of the anterior surface of the vertebral body. At the apex of the curve, the black dot is maximally displaced towards the convexity and the vertebral body is maximally rotated.

The effect of the rotation deformity on the thoracic cage is devastating when severe (Fig. 3). The pleural cavity on the side of the convexity is effectively obliterated and the ribs are closely applied to the bodies of the vertebrae. The rib hump, which in severe cases forms a sharp edge and is known as a 'razor back', adds a distressing cosmetic disability and indicates an irreversible change. The diaphragm is embarrassed on the same side because the origin and insertion of the muscle are closely apposed; in effect, the diaphragm lies in loose folds on one side and is stretched on the other, adding to the functional loss.

Each component of the scoliotic deformity is of a structural, not functional nature which means that the patient is unable to restore or reverse the curve by voluntary effort.

A third component is hyper-extension of the spine into a position of lordosis in the normally kyphotic thoracic spine, and of hyper-lordosis in the lumbar region. When a black dot is placed at mid-point on each anterior vertebral surface, then a series of dots when linked together will be seen to outline the convex arc of the curve (Fig. 3). Expressed in other words, the line joining the black dots runs parallel with the margins of the **anterior longitudinal ligament,** which is stretched across the arc of the curve, and serves to emphasize the fact that the spine is indeed hyper-extended.

The effect of the lordotic curve in the thoracic spine is devastating in severe cases, for the vertebral bodies are literally pushed forward to approximate the sternum and the mediastinal space is reduced or obliterated (Fig. 3).

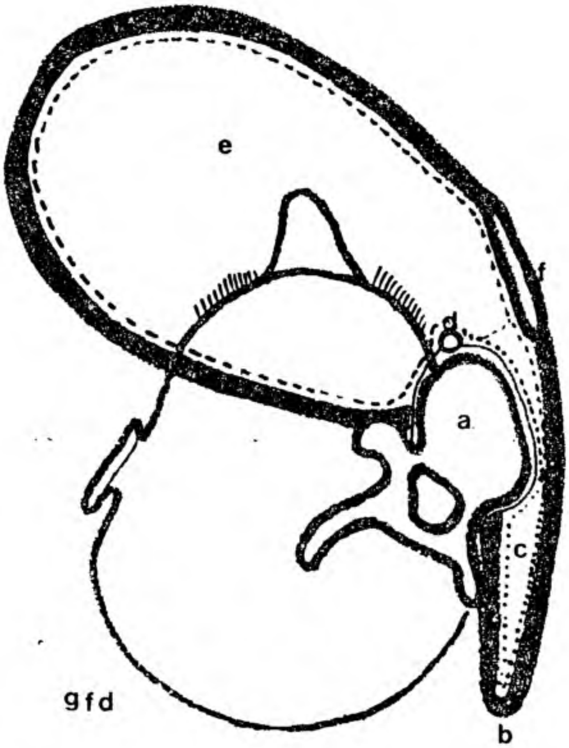

Fig. 3: Diagrammatic representation of a bird's eye - view showing a silhouette of the skull of a patient with severe thoracic scoliosis, convex to the right side. (a) Vertebral body rotated towards the side of the convexity of the curve. (b) The rib hump. (c) The obliterated pleural cavity on right. (d) The aorta. (e) The unicameral pleural cavity which contains left and right lungs and mediastinal contents including the heart. (f) The sternum.

Cardiac embarrassment and cardio-pulmonary insufficiency are unfortunate and more serious complications which account for premature death during the third or fourth decade in an appreciable percentage of cases. Winter colds and flu are a special hazard.

In lumbar curves the effects are less serious and the life of the patient is not threatened. The complaint in these cases is of lumbar backache which increases to intolerable proportions and may necessitate operation for spinal fusion. There is loss of vertebral alignment and degeneration of the intervertebral discs, leading to instability (Fig. 4).

Fig. 4: Radiograph of a forty-eight-year-old white female with lumbar scoliosis. Instability is severe at L.3/L.4 level on account of intervertebral disc degeneration due to shearing strain.

Lordo-scoliosis is much more common than kypho-scoliosis, and is the typical deformity seen in idiopothic cases.

Kypho-scoliosis is relatively rare and the kyphotic or clasp-knife component is the significant part of the curvature, not the scoliosis. From the point of view of management, the scoliotic component may be ignored.

Kypho-scoliosis is usually the result of a congenital anomaly such as an absent vertebral body, or a congenital hemi-vertebra in which the anterior half is missing and the spinal column is 'buckled' forward, or in which there is congenital failure of segmentation (which means fusion), of two or more vertebral bodies. In the latter event, the growth centre for the vertebral body is absent, while the growth centres for the neural arches are present. The latter continue to grow and to produce a progressive deformity.

Kypho-scoliosis is associated with a grave risk of cord compression and paraplegia, because there is kinking and narrowing of the spinal canal at the level of the lesion.

In lordo-scoliosis by contrast, paraplegia is an uncommon spontaneous complication, as the spinal canal is widened in the region of the curve.

Less common causes of kyphoscoliosis are neurofibromatosis and paralytic lesions of all etiological types. In the latter there is collapse of the 'floppy spine', brought about by sitting erect.

In both the lordotic and the kyphotic deformities, there is a compromise of lung function, and the vital capacity is reduced. An additional factor in the reduction is the effect of the spinal deformity on the ribs. On the convex side (Fig. 2), the ribs are more obliquely placed and the costo-transverse and costo-vertebral joints are mal-aligned. On the concave side, the ribs are crowded and the rib-vertebral body angle is increased. Each of these joints is a synovial lined joint cavity, in which the range of movements is adversely affected.

In paralytic cases, the intercostal muscles are generally involved to the extent that there is paradoxical breathing. In non-paralytic cases, the intercostal muscles and the diaphragm are functionally paralysed because of the deformity of the rib cage.

Nor is respiratory insufficiency the only disability associated with scoliosis. Rather, the severe case should be regarded as a 'triple cripple', who suffers from cardio-pulmonary, cosmetic and physical (spinal) disability. There is yet a further, more sinister complication which is that of neurological loss and paraplegia.

TREATMENT:

Conservative measures remain the background of all treatment of scoliosis, and can be effectively applied when early diagnosis is made. The Milwaukee brace has became standard practice, and the balanced traction of Cotrel, which is applied only at night, has evoked increasing attention in recent years.

Perhaps the most important aspect is the team-work which is implied. The physiotherapist is an important member of a team which includes a physician, surgeon, anaesthetist, pathologist, and nursing sister in the intensive care unit, the operating room, the ward and the out-patient department. There are the occupational therapist, the social worker and the orthotist. There are the radiographer and the clinical photographer. There are the parents and the school teacher whose understanding and co-operation are vital. Last but not least there are the registrar, the house doctor and the plaster room assistant.

The role of each member of the team is important in the end-result to be gained. The team is only as strong as its weakest member.

The attention of the physiotherapist is directed at posture and at the strengthening of such muscles as are weak from disuse or paralysis.

The joints of the spine and limbs are to be put through their normal range of movements at frequent intervals even during the pursuit of the child's normal activities. The latter instruction must of course bend to the rules of reason.

Contractures of joints are to be prevented, and recognised when already present. Efforts at their correction are made in consultation with the surgeon.

Pulmonary function in the more severe cases receives top priority and the progress of the child is recorded periodically. So that the child may not be given false encouragement by a kind, soft-hearted clinician who is lenient in his or her interpretation of the tests for respiratory efficiency, the writer offers a single test which cannot be faulted nor the results altered.

The test consists of the under-water holding of the breath for as long as the child is able, after being allowed to hyperventilate for as long as desired. The submersion test can be performed only in selected instances, but it is more valuable and more significant than the standard tests which are valid only in so far as the patient is co-operative.

In carefully recorded cases, the fluctuations in respiratory efficiency are often remarkable, and when retrogression is noted it may be attributable to non-co-operation and lack of discipline. **Operative procedures are ineffective in improving respiratory function.**

The value of exercises in controlling and/or correcting scoliotic curves is no longer a contentious matter. **There has been no exercise devised which improves or corrects scoliosis.** Nevertheless, exercises are valuable for the scoliotic just as for the healthy individual, and the physiotherapist includes exercises in her repertoire of treatment, along with other modalities.

In the pre-operative and post-operative phases of surgical care, the physiotherapist plays a vital role not only in breathing exercises but also in the application of Intermittent Positive Pressure Respiration (I.P.P.R.) and in the management of endo- and intra-tracheal intubation.

The controversial schoolbook bag and suitcase deserve mention, in order that misunderstanding may be allayed. When a normal healthy child is overloaded, the effect is to sag and collapse which is an intolerable situation. An immediate reduction in the load is mandatory. Alternately, with a load which is tolerable, the individual will respond not by sagging or collapsing, but by an unconscious bracing of the muscles so that the part under load straightens up rather than collapses. Van Niekerk (1970) showed that a load of 100 kilograms placed on the head of a porter causes the normal curves of the neck to straighten out, provided the porter is able. A heavy suitcase when carried in one hand causes the shoulder to brace on that side and to become elevated, while the trunk is bent over to the other side in order to maintain equilibrium. A heavy book bag slung between the shoulders causes a child to lean forward in order to continue his or her forward progress. If too heavy, it will cause the child to fall over backwards—which is an intolerable situation.

The important question is whether or not the bearing of a load which the child can manage, but which exceeds physiological limits, causes harm. There are many factors involved including the age and weight of the child, the period over which the load is carried, the manner in which it is borne, the physical condition of the child. Newman (1974) quoted a series of military trainees who developed a stress fracture of the pars inter-articularis of a lumbar vertebra after carrying a pack weighing 56 lbs. over a distance of 40 miles. Lamy, Kraus and Bazergui (1974) showed that mechanical loads applied to the vertebrae of fresh cadaver specimens in a manner which resembled loading in the living individual, while the spine was forward flexed, resulted in the same lesion quoted by Newman. Schultz and co-workers (1974), also King Liu and associates (1974) studied methods and results of compression and shear loads on the intervertebral discs and yielded evidence that excessive compression forces cause radial tears of the bony end plates of the vertebral bodies. They showed that the bony end plates are more susceptible than the cartilage rings, and that a much greater force is needed to produce compression fracture of the vertebral bodies. Shear forces are more harmful than compression forces.

The question of injury to the cartilaginous epiphyseal rings of the thoracic and lumbar spine in the growing child under conditions of loading **which exceed physiological** limits has not yet received detailed attention and once again there are many variable factors. If for instance the child bends forward by utilising the hip joints, and at the same time maintains a straight (rigid) spine, then it is unlikely that there will be any damage.

At this stage of our knowledge, and bearing in mind the various ages, sizes and requirements of school children, it is necessary to rule that in all cases the weight of book bags and satchels be within physiological limits irrespective of whether they are borne in the hand or on the shoulders.

The conclusion is that in healthy children, book bags and suitcases do not cause harm, provided the weight is within physiological limits. In the scoliotic child, and in paralytic or other abnormalities, the carrying of school bags should be controlled and limited, under doctor's instruction.

CONCLUSIONS:

The results of neglect of scoliosis are disastrous and often fatal.

The neglected patient is subject to triple crippledom, and a fourth more sinister disability may be paraplegia.

Early recognition of the case is mandatory, and treatment must be instituted from the moment of diagnosis.

Conservative treatment may be effectively applied with relative ease in the early case and offers the only chance of 'resolution', that is, return to normal.

Surgery in scoliosis is largely a salvage procedure, the 'second best', and a modality which has a bone-grafted, fused spine as the final objective. Clearly a fused spine is not as good as a mobile one.

Physiotherapeutic modalities of treatment along guided lines are vital to the welfare of the patient, and the physiotherapist is a key member of the team along with other medical and paramedical colleagues.

The routine examination of school children is recommended, and where already carried out has enabled early diagnosis in many cases.

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