of the bladder or Raynaud's disease, section of the nerves involved has a beneficial result, but in the normal economy the sympathetic, like the appendix or gall-bladder, can be dispensed with.

The observations on the pulse rate and blood pressure were conducted by Dr. Ghosh, who took a keen interest in the work. I have also to thank my house-surgeon, Dr. Apparajoo, for his careful clinical record of both cases.

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FRACTURES OF THE SPINE

TREATMENT AND TRANSPORTATION*

BY

W. S. HAUGHTON, M.D., B.CH.

SURGEON TO STEEVENS' HOSPITAL, DUBLIN, AND TO THE ORTHOPAEDIC HOSPITAL OF IRELAND; HONORARY PROFESSOR OF ORTHOPAEDIC SURGERY, DUBLIN UNIVERSITY; PRESIDENT, RADIOLOGICAL SOCIETY OF IRELAND

(With Special Plate)

Fractures of the spine, by which I mean crush fractures of the bodies of the vertebrae, constitute a much commoner injury than was formerly supposed—perhaps even a commoner injury than is at present fully recognized. In proof of this I may state that not long ago five cases of fractured spine came under my own care in six months. But apart from the frequency of this injury, its seriousness, both in the immediate consequences of the graver forms with compression of the cord, and also in the later complication of minor degrees, cannot be too heavily stressed. With regard to the minor degrees, all orthopaedic surgeons are familiar with the "wedging" of vertebral bodies, as seen in the lateral profile of the spine, in cases referred to them complaining of increasing pain and disability in the back following a fall some months previously. This pain is localized, and sometimes radiating. The late Sir Robert Jones never tired of impressing on us that callus forming round a fracture was definitely soft for variable and prolonged periods, and that up to six months from accident such callus might permit deformity to increase by bending, compression, or shearing at the site of fracture, if premature weight-bearing was permitted.

Everyone is aware that "crush fractures" (compression fractures) of the bodies of the vertebrae may at first present very slight deformity on the x-ray film, but a crush fracture implies an inflamed bone, and rarefying osteitis soon softens this bone sufficiently to permit gradual, or even rapid, "wedging" of the bodies if premature weight-bearing is allowed. These facts sound the clarion call of preventive medicine—namely, (1) for the earliest possible diagnosis, and (2) for the earliest possible correct transportation and treatment if deformity, disability, and even death are to be prevented.

EARLY DIAGNOSIS

If a man has a heavy fall, and is partially or completely paralysed from the waist down, anyone can diagnose a "broken back." But in cases where the spinal cord is not at once involved the patient may walk, though he complains of severe, persistent, localized spinal pain. All such cases should at once be submitted to a very careful antero-posterior and lateral x-ray examination. A true conception of "crush fractures" and fracture-dislocations of

the spine, as regards (1) frequency, (2) degrees of severity, and (3) late "wedging" of injured vertebral bodies, has only been rendered possible by the improved technique in obtaining lateral (profile) views. By this method any alteration in the general antero-posterior curves of the spine can at once be detected, as well as any change in shape or relations of the individual bodies of vertebrae.

PRINCIPLES OF TREATMENT

To appreciate the mechanics of treatment we should try to understand the mechanics of the cause. In most cases of wedge-shaped vertebrae following injury we find the wedge shallower in front and deeper posteriorly. Assuming the spine to be a column of support, or flexible girder, this wedging, shallower in front, indicates the crushing force to be greater in front. This suggests *flexion of the spine* in excessive degree to be the cause. In my experience, the lower dorsal and upper lumbar vertebrae are those more frequently affected by "crush fracture." Here again we have the normal curve of dorsal kyphosis (convex backwards) changing to lumbar lordosis (convex forwards). Change of curve in any structure constitutes a source of weakness under undue strain. Assuming, then, that excessive flexion is the cause, we have compression in front of the spine and tension at the back. This fractures the body of one or more vertebrae by crushing into a wedge shape, and, if the force continues to act, this wedge-shaped body tends to slide backwards by dislocation, and may involve the spinal cord by immediate direct bony pressure, or by subsequent pressure due to haemorrhage or inflammation. During excessive flexion of the spine we have relaxation of the anterior longitudinal ligament. If this is not torn we have a possible factor for reduction of deformity in the pull which it can exert during extension and hyperextension of the spine.

REDUCTION BY EXTENSION

The late Professor Kocher of Berne, at whose clinic I spent several months, showed us his method of reduction for fracture-dislocation of the cervical spine ("cherry-tree fracture"). It was as follows:

1. A leather sling, shaped to occiput and chin, was applied, and strapped to head of patient's bed.
2. The professor's assistant, standing at the foot of the bed, grasped the patient's ankles, and at the word of command began a steady, slow, progressive, heavy traction on the spine, through the legs and pelvis.
3. The professor's fingers and thumbs manipulated the neck during extension, and recorded the "click" of reduction.

I had the privilege of seeing three such cases recover in the same month, and witnessed one of the reductions (1902).

For dorsal and lumbar fractures my own technique has been:

(a) *In Recent Cases* (soon after injury).—Place the patient face downwards on a hard table, with a large sandbag lying transversely under the upper part of the thorax, and another large sandbag (or bags) transversely under the pelvis. This produces a very marked "hollowing" of the back, with hyperextension of the spine. In this posture of hyperextension a posterior plaster spinal shell is applied. On this plaster shell, lined with felt half an inch thick, the patient is nursed in bed for three to six months, and is then allowed up in a spinal support, with axillary crutches, to be kept on for twelve months or more.

(b) *In Later Cases* (three months or longer after injury).—With these I use Whitman's modification of the Bradford spinal frame, in the hope of obtaining gradual reduction. If this is not tolerated I use the posterior plaster shell to give anatomical fixation and physiological rest, followed by a spinal support as above.

To a vice-president of this Section, Professor Harry Meade, I owe a very deep debt of gratitude for introducing me to Dr. Böhler's methods of fracture treatment,

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which I have followed closely for four years. To Dr. Böhler himself I owe a debt which can never be repaid—a debt which is shared by most orthopaedic surgeons, and by humanity at large. In November and December, 1930, I had the pleasure of meeting Dr. Böhler in London and in Dublin. He then explained to us his method of treating "crush fractures" and fracture-dislocation of the spine by "suspension." This appealed to me as being both practical, powerful, and simple. In fact, like all his other work, it represents applied anatomy, applied physiology, and applied mechanics rolled into one—*Teres atque rotundus*. Below I cite an instance of its use.

In May, 1931, my next case of fracture-dislocation of the spine turned up for treatment, with compression of the spinal cord. Riding a horse in Phoenix Park, the patient was knocked against a tree and thrown off. On examination it was found that he had a crush fracture of the ninth dorsal vertebra, with wedging of its body and dislocation backwards and sideways. The spinal cord or its nerve roots was also compressed, with complete motor paralysis of the right leg, partial sensory paralysis of the left leg, and loss of control of bladder and rectum. After consultation with my neurological colleague, Professor F. C. Purser, I decided to treat the patient by Böhler's suspension method. The anaesthetic used was 1/3 grain of morphine. For this suggestion I am indebted to Mr. Watson Jones: this anaesthetic was completely successful. A brief description of the four stages of the treatment is given below (see Plate).

Stage I: The patient lies face downwards on two tables, placed to form a T, the head and shoulders only resting on the transverse table, the body and legs on the other. *Stage II:* The ankles are padded thickly with felt, placed between and around. A rope is made fast around the padded ankles by a "clove hitch," and suspension tackle is hooked on. *Stage III:* The ankles are slowly hoisted from the horizontal to the vertical, thus exerting powerful traction in the axis of the spine, and hyperextension in the anatomical sense. This stage should occupy twenty minutes, and during it partial or complete reduction of the fracture-dislocation should be effected. *Stage IV:* The table under the body and legs is removed, and on the hyperextended spine a posterior plaster shell, suitably padded with felt (or a complete plaster jacket), is built up, and the patient lowered.

In ten days after suspension this patient began to move the previously paralysed toes, and two days later he recovered control of bladder and rectum. From the twelfth day he recovered the lost motor power and sensation gradually, and this was completed in three months. After three or four weeks he was given an anterior spinal shell, and then nursed for six months in a posterior shell by night and an anterior shell by day. In the latter he was encouraged to use his spinal muscles, which he did vigorously. X rays proved the dislocation completely reduced, and the wedge-shaped body of the ninth dorsal vertebra to be reconstructed in true rectangular shape when seen in profile. Six months after the accident he was allowed up in a special spinal support of poroplastic and steel lattice of my own design, which carried a pelvic girdle and axillary crutches to prevent any further compression of injured vertebrae. One year after breaking his back he learnt to swim the "crawl stroke," and he is now a creditable performer.

TRANSPORTATION OF SPINAL FRACTURES

If suspension of the body with the spine in *hyperextension* is the method of choice in treating these fractures, as has been amply proved by Dr. Böhler and those of us who closely follow his technique, then to transport a patient suspected to have this injury in any other position becomes, in my opinion, an act of gross neglect. I wish here to record my indebtedness to Mr. Watson Jones (who has his own admirable method of hyperextension for these fractures) for his suggestion to transport these cases *face downwards*. If the patient is placed face downwards on the stretcher, with a roll of coat, blanket, or sandbag transversely under the upper part of the chest, and another transversely under the pelvis, the spine will sag by gravity into the posture of hyperextension. In this

posture automatic reduction of the deformity may even occur during the period of transportation; but in any case the injury is not made worse. I am gratified to think that my friend Sir John Lumsden, commissioner of the St. John Ambulance Brigade in Ireland, had the courage more than two years ago to make an order that all patients suspected to have this injury should be transported face downwards by all officers and men working in his district. To prove the wisdom of his decision I may quote a case from Canada, which occurred twenty years ago.

A former pupil of mine, Dr. Cecil Boyd, while surgeon to a mining camp, was called to a lumber camp, where a "tree-rigger" fell about one hundred feet into smaller trees. He was much torn and lacerated, semi-conscious, and paralysed from the waist down. After dressing his wounds, Dr. Boyd noticed that he made persistent efforts with his arms to turn over on to his face. Finally Dr. Boyd decided to turn him over, face downwards, with a roll under chest and pelvis. In this position he was transported 150 miles over rough country to hospital, without moving, and recovered from his broken back and paralysis.

As regards cases of broken neck (fracture-dislocation of the cervical spine), the best authenticated accounts of this accident suggest that it occurs in flexion. Kocher has proved that extension of the spine and hyperextension of the head and neck provide a method with many successes to its credit. Therefore, in my opinion, any case which is conscious, but paralysed in both arms and both legs, should be transported with the head and neck hyperextended over a small hard pillow or sandbag, cylindrical and four inches thick, placed transversely behind the neck and above the shoulders. For this form of spinal fracture the patient should be transported on his back.

HAEMANGIOMA OF THE SPINE

BY

F. STRONG HEANEY, F.R.C.S.IREL.

HONORARY SURGEON, LIVERPOOL STANLEY HOSPITAL AND LIVERPOOL CANCER HOSPITAL;

AND

P. H. WHITAKER, M.B., M.R.C.S., D.M.R.E.

ASSISTANT LECTURER IN RADIOLOGY, UNIVERSITY OF LIVERPOOL;
HONORARY ASSISTANT RADIOLOGIST, LIVERPOOL ROYAL INFIRMARY; ASSISTANT RADIOLOGIST, RADIUM INSTITUTE AND CANCER HOSPITAL

(With Special Plate)

Since the first radiograph of a haemangioma of the bone was published in 1917 by Hitzrot¹ numerous other cases have been recorded, and it has become possible by comparison of these findings to recognize haemangioma of the vertebrae. In January, 1930, Bucy and Capp² reviewed all the recorded cases and classified the radiological findings, stating that they considered a diagnosis could be made from the radiograph in the majority of cases. Haemangioma of the vertebrae differs from haemangioma elsewhere, and presents a definite radiological picture of its own. It has been stated that haemangioma of the vertebrae is rare, and clinically this appears to be true. Bucy and Capp³ found only eleven recorded cases which had produced symptoms. These were not isolated to any age period, but women were affected more than men in the proportion of nine to two. In all but one of the cases the symptoms were those of a compression myelitis, and were indistinguishable, except by x rays, from an extramedullary tumour. In the other case, that of Makrycostas,⁴ the symptoms were not recorded.

Pathologically haemangiomata are not rare, numerous cases having been recorded post mortem—limited, however, to the body of the vertebra, and not producing

W. S. HAUGHTON: FRACTURES OF SPINE. TREATMENT AND TRANSPORTATION

FIG. 1.—Extension and hyperextension of spine by Böhler's "slinging" method. First stage. Patient lying face downwards on two tables, upper one supporting weight of head, neck, and shoulders only.

FIG. 2.—Second stage. "Slinging" begun; hoisting by means of double and single block.

FIG. 3.—Third stage. Twenty minutes after second stage: hoisting now completed. Note extension in long axis of spine and anatomical hyperextension of spinal curves.

FIG. 4.—Fourth stage. Posterior plaster-of-Paris shell completed in thirty-five minutes.