

intrinsic factors must be considered in the management of any patient with spinal deformity after such injury or disease. Treatment has been considered in a number of cases.

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### SPINAL DEFORMITY AFTER SPINAL CORD INJURY

By PHILLIP HARRIS, F.R.C.S.E., F.R.C.P.E., F.R.C.S.(Glas.), F.R.S.E.,  
and W. J. WHATMORE, M.B., Ch.B., F.R.C.S.E.

*Department of Surgical Neurology, Royal Infirmary  
and Western General Hospital, Edinburgh*

SPINAL deformity may appear at the time of spinal cord injury or soon after this has occurred, or after a long interval. The assessment, investigation and management is determined by the individual features of each patient.

In this paper we do not intend to include a discussion of either penetrating spinal injuries or of spinal deformities resulting from muscle imbalance.

Some examples of spinal deformity after spinal cord injury will be given from an experience of patients seen in the Spinal Injuries Service in Edinburgh during the past 25 years.

**A. Time of Occurrence of the Deformity.** Usually the maximal displacement of the vertebral column occurs at the moment of injury, and damage to the neural and vascular elements appears at this time. Depending on the type of injury, the direction of the force and the anatomical region of the spine involved, the deformity of the vertebral column may be:

(1) A fixed, persistent deformity. This is seen, for example, in severe hyperflexion injuries of the cervical spine with dislocation and locked articular facets, with or without fracture of the articular processes.

(2) A latent or concealed deformity which can be present in certain patients with cervical injuries and only be revealed by careful radiological-movement studies.

(3) A deformity which has reduced spontaneously, for example in a patient who has sustained a severe hyperextension cervical injury, and who may be left with serious neurological deficits. However, in many of these patients a significant degree of cervical spondylosis is seen in the radiographs (Harris, 1968*b*).

(4) A non-bony persistent deformity; thus plain radiographs may not reveal any bony deformity, although specialised studies or operation can demonstrate relevant deformities of the intervertebral discs, or of the dura mater and nerve roots (see later).



FIG. 1

Fig. 1.—A radiograph taken on admission of a patient after spinal injury revealing a C2/3 fracture-subluxation.

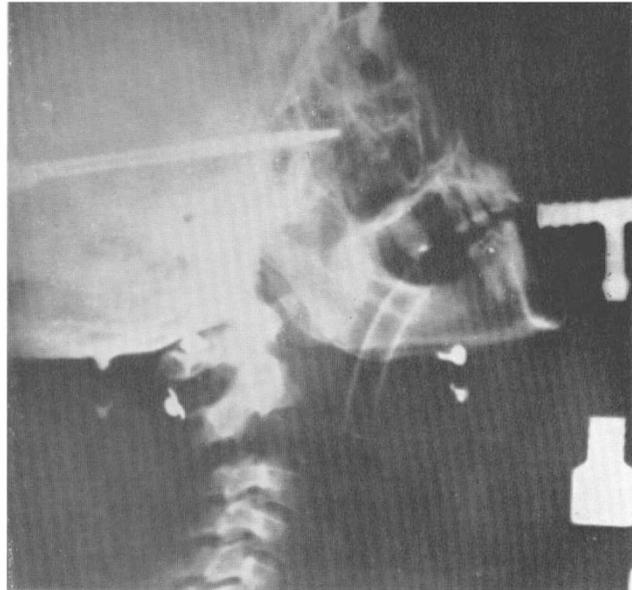


FIG. 2

Fig. 2.—The result of manipulation under anaesthesia of the same patient causing extreme distraction of the cervical vertebrae and endangering neural tissue.

(5) An associated bony and non-bony deformity. Not all spinal deformities are apparent initially, and indeed they may only be detected clinically or radiologically some time after the injury. Certain additional or recurrent spinal injuries may result from mishandling or maltreatment at various stages in the management of the patient:

- (i) During 'first-aid' (pre-hospital treatment), including extrication from vehicles, and during transportation to hospital.
- (ii) During the handling of the patient on arrival in hospital, for example when being undressed or lifted, and during clinical and radiological examination.

- (iii) Neural damage may result from improper medical treatment, including careless turning of the patient, failure to maintain correct traction and reduction, and inadequate spinal fixation. Particular care is necessary for the anaesthetic intubation of patients with cervical spine injuries, and for the manipulation of patients with spinal injury (figs 1 and 2) (Harris, 1965).

Deformities of the vertebral column and associated spinal cord injury may be much delayed, occurring weeks, months or even years after the initial injury.

**B. Problems in Diagnosis.** A carefully elicited history and an efficient neurological examination will usually indicate the presence, level and clinical type of spinal cord injury. An associated spinal deformity may be suspected on consideration of the type of injury, the presence of relevant associated injuries (Harris, 1968*a*), such as head injury, fractured jaw or calcaneus; the clinical detection of a gibbus, and malalignment or separation of spinous processes. Equally significant is progression of the neurological lesion.

Establishment of the presence and type of spinal deformity and neural damage requires correct and adequate radiological investigation. All patients require plain radiographs, antero-posterior and lateral, at all suspected levels. Open-mouth views are employed for atlanto-axial injuries and it is necessary to pull down the shoulders for views of the lower cervical spine (see later).

Certain patients will, in addition, require one or more of the following radiological investigations:

- (1) Movement studies are used to reveal latent spinal instability; the patient must be properly supervised by an experienced doctor during the investigation.
- (2) Tomography may be used to define deformities of the atlanto-axial, and of the cervico-dorsal vertebral regions.
- (3) Myelography should always be available in the investigation of patients with spinal injuries, as only this technique will reveal certain significant deformities of the intervertebral discs, and of the spinal theca (Harris, 1965).
- (4) Discography and angiography are occasionally employed in the further investigation of patients with spinal disc injuries.

Spinal deformities are missed mainly for the following reasons:

- (i) A spinal deformity is not suspected, and radiographs are not taken. The usual reason for this is that the presence and effect of other injuries removed the suspicion of a spinal injury. This includes the situation where a patient has a combined head and spinal injury, and is unconscious from the former (Harris, 1968*a*).
- (ii) Radiographs are taken but the studies are inadequate and do not reveal the lesion. The reason for this may be due to failure to pull down the shoulders (figs 3 and 4); failure to perform movement studies; or ignorance of the need for myelography (fig. 5).
- (iii) Doctors may fail to recognise a spinal deformity which in fact has been adequately disclosed by radiography.
- (iv) Spinal deformities may be adequately diagnosed at one level but unsuspected and missed at another level.

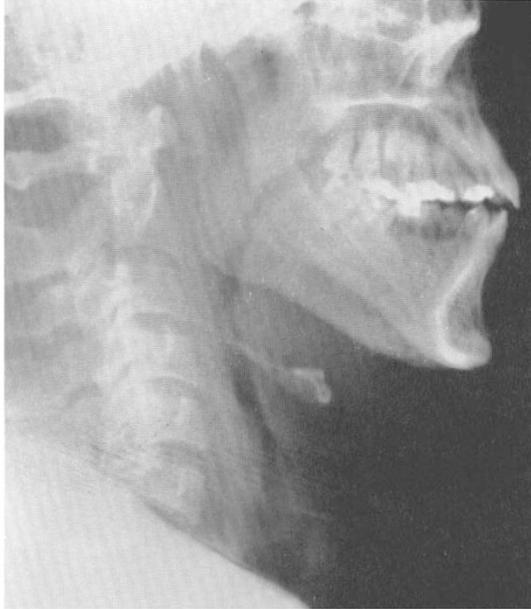


FIG. 3

The admission lateral cervical spine radiograph of a patient after cervical injury.



FIG. 4

A repeat lateral radiograph of the same patient with the shoulder pulled down showing the necessity and usefulness of this procedure.

**C. The Significance of the Spinal Deformity.** The neural damages suffered at the time of injury may be irreversible, or there may be some degree of neurological recovery; we believe that in certain patients an untreated or inadequately treated spinal deformity can prevent neurological recovery and may even permit or cause further deterioration either at an early or at a late stage. Slight or severe



FIG. 5

This myelogram was performed on a patient rendered quadriplegic after spinal injury in whom plain films did not reveal an obvious lesion and who deteriorated neurologically. A marked acute disc protrusion is seen at C7/D1.

spinal deformity may be present without the coexistence of any neurological abnormality.

(I) With reference to unstable deformities there is a real risk of further compression of the neural and vascular elements and this situation is seen particularly with certain dislocations and fracture-sluxations of the cervical spine, and in certain patients with lateral fracture-dislocations at the dorso-lumbar junction. Reduction and fixation of these deformities may lead to surprising degrees of neurological recovery.

(2) Fixed deformities can be important, thus in partial cord lesions or in cauda equina lesions, fixed gross displacements are not be the condition for the neural tissues to achieve recovery of function.

(3) Plain radiographs may show successful reduction of the bony deformity, but myelography may reveal a remaining significant intervertebral disc protrusion.

(4) Injuries of the lumbar spine may cause obvious vertebral column deformity, but in addition there may be an 'internal' deformity in the form of dural and arachnoid tears and prolapse of the cauda equina roots. These lesions may only be demonstrated or suspected after myelography has been performed, and/or at operation (Harris, 1965, 1967).

**D. Late Sequelae.** Neglect of a significant spinal deformity may lead to the development of late sequelae including an increase in the deformity, increasing—or the first appearance of deterioration of neurological deficits, or to the establishment of permanent deformation such as excess callus formation with delayed progressive spinal cord compression (Schneider, 1962); or to fixed and adherent prolapsed nerve roots (Harris, 1967).

There are two main reasons for late sequelae:

(1) Absence of treatment of the deformity resulting from failure to recognise and diagnose the condition, or failure to appreciate the significance of the deformity and therefore to carry out appropriate treatment.

(2) Inadequate initial treatment, thus although the lesion was recognised initially treatment was insufficiently applied.

In addition we would stress the necessity for repeat check radiographs at intervals, especially in the early months following spinal injury; and sometimes in the later period.

#### SUMMARY AND CONCLUSIONS

Vertebral column deformities may persist after spinal cord injury, and they may be of bony, articular, soft tissue, vascular or neural elements or any combination of these. Displacement may become fixed at the time of the injury or may be latent and appear or worsen later. Spinal deformities may be missed unless proper radiological examination is performed in all patients in which they are suspected, and specialised radiological techniques may be necessary to reveal latent deformities, or the presence of disc protrusions and dural arachnoid tears.

The significance of the spinal deformity has been discussed in relation to the spinal cord injury and the whole management of the patient. In certain patients neurological recovery will only ensue if adequate surgical techniques are instituted to decompress, re-align and stabilise the displaced structures. Neglectful or inadequate treatment may lead to persistence or deterioration of the neurological deficit or to the onset of late sequelae.

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### EARLY TREATMENT OF TRAUMATIC PARAPLEGIA AND TETRAPLEGIA BY A NEW METHOD, USING A 'ROLLING PLASTER JACKET' OR A 'ROCKING PLASTER SHELL'

By KENGO YAMADA, M.D., and TAKAAKI IKATA, M.D.

*Department of Orthopedic Surgery, School of Medicine, Tokushima University, Japan*

I WOULD like to introduce our method of early treatment for spinal injuries. Our method is conservative, and consists of using a 'rocking plaster shell' or a 'rolling

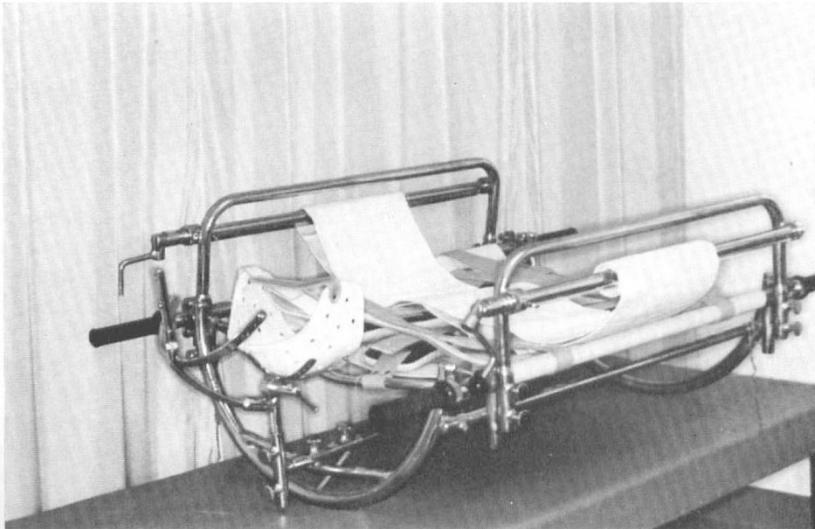


FIG. 1

plaster jacket', which has been routinely applied to 47 cases in our Clinic since 1965. As it is well known, plaster casts for paraplegics are not usually recommended, because of fear of causing bed-sores and weakening of the back muscles.

However, at our Clinic this method has been proved to be safe as well as easy, and our concept is also supported by theoretical and experimental evidences. In Japan, economical conditions in the medical field are still rather poor and the