A SYNDROME IN ACUTE CERVICAL SPINE INJURIES FOR WHICH EARLY OPERATION IS INDICATED

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In acute cervical spine injuries an immediate complete paralysis with hypesthesia at the level of the lesion and an associated sparing of touch and some vibration sense is a syndrome for which early operative intervention is indicated. Two cases are presented here in which a diagnosis of acute extruded nucleus pulposus was made preoperatively on the basis of the syndrome, and the lesion was confirmed at operation. It is hoped that a discussion of these cases may lead to an earlier recognition of these lesions with the prevention or diminution of residual neurological disability.

The production of this syndrome may be explained on a precise anatomical basis. In May, 1947 Kahn presented a paper which first described the role of the dentate ligaments in chronic anterior spinal cord compression by a posteriorly protruded cervical nucleus pulposus. In these cases the symptoms of spasticity, hyperreflexia, disturbance of gait, and modified sensory changes simulate a degenerative lesion of the cord, such as lateral sclerosis. Previously it was believed that these symptoms were on the basis of compression of the anterior spinal artery. However, Kahn has indicated that the spinal cord may be firmly fixed by the fragile-appearing, but remarkably strong dentate ligaments so that posterior displacement of a herniated disk causes paralysis by anterior cord compression with exertion of stress upon the cord just above the attachment of the dentate ligaments. The publishers have very kindly permitted me to reprint Fig. 1 from the original article which shows these lines of stress (Fig. 1). I would like to quote from this article: “In anterior spinal cord compression I believe that, with pressure over a period of time, the pyramidal tracts, because of the greater stress on them and the large size of their fibers, have more disturbance of conductivity than the pain fibers of the spinothalamic tracts, even though the latter are closer to the compressing mass, be it midline herniated nucleus pulposus or tumor. Touch is preserved because, even though the touch fibers of the ventral spinothalamic tracts may fail to conduct, there is still sufficient sensation carried in the more protected posterior columns to prevent the clinical detection of touch disturbance. Postural sense is preserved because the attachment of the dentate ligaments prevents the posterior columns, which are farthest from the compressing mass, from being pressed against the unyielding laminae.”

Bucy, Heimburger, and Oberhill in their article on compression of the
cervical cord by herniated disks are inclined to accept Kahn's mechanical stress concept as the cause of symptoms rather than the theory of possible compression of the anterior spinal artery.

In both of these articles the authors have presented cases in detail that demonstrate the insidious pathogenesis of this type of lesion which simulates chronic degeneration of the cord. It should be emphasized that in these chronic cases there is a gradual development of symptoms, but in the acute

![Diagram of Stress Analysis]

**HERNIATED DISK**

(Diagram of Stress Analysis)

- Dura mater
- Posterior columns
- Pyramidal tract
- Line of equal stress
- Dentate ligament
- Herniated disk
- 6th cervical intervertebral disk
- Lateral spino-thalamic tract
- Ventral spino-thalamic tract

Fig. 1. "Showing lines of stress in anterior spinal cord compression. Greatest stress is anterior on tracts disturbance of which would not be demonstrable by clinical tests. Secondary stress is directly on pyramidal tracts. The leg area is most lateral in pyramidal tracts, while the hand area is most medial, explaining usual sparing of the hands." (Reprinted by courtesy of Dr. E. A. Kahn.)

Nevertheless, the author is inclined to believe that the same mechanical stress factor is of fundamental importance in both the chronic and the acute types and feels that the following 2 cases illustrate that point.

**Case 1.** J.S., 36 years, white male, was involved in an auto accident on Aug. 21, 1948, and was thrown from his truck and pinned to the ground under it. He recalls lying beneath the truck, numb from the neck downward, and was unable to move either lower extremity. He was given first aid treatment at the local hospital and on the following day was transferred to St. Luke's Hospital, Cleveland, Ohio.

**Examination.** The patient had point tenderness over the lower cervical spine, weakness in his grip, paralysis of both lower extremities, and a level of hypesthesia at the C7 dermatome. However, there was no apparent loss of touch. There was abdominal distention, with urinary retention, priapism, and complete areflexia.
No pathological reflexes were observed. Routine roentgenograms of the cervical spine showed no evidence of fracture or dislocation. On August 24 the neurosurgical consultant performed a careful cervical myelogram which revealed no evidence of block or distortion of the pantopaque under fluoroscopy. However, the head could not be adequately hyperextended to pool the contrast medium properly for fear of causing further cord damage. On August 25, the level of hypesthesia persisted at the C7 dermatome with the preservation of touch. There was diminution of vibration sense, with slight weakness in extension of arms at the elbows, some impairment of the grip, and paralysis of the lower extremity bilaterally. Because of the neurological signs a diagnosis of herniated nucleus pulposus at the 6th and 7th cervical interspace was made in spite of the negative but somewhat inadequate myelogram.

Course. On August 26 Crutchfield tongs were inserted to insure immobilization of the spine, and the patient was placed on a Stryker frame in order to provide better nursing care. After 3 days there was a slight drop in the sensory level from the C7 dermatome bilaterally to the D5 dermatome on the left and the D7 on the right. The grip in both hands appeared slightly improved, but there was no change in the motor status of the lower extremities. On September 2 there was regression of the sensory level to the C7 dermatome with the same degree of impairment of motor power as at the time of admission. The diagnosis of herniated nucleus pulposus was again suggested.

Operation. Laminectomy of the 5th, 6th, and 7th cervical vertebrae was performed 11 days after injury. A simple linear fracture without depression was found in the lamina of the 6th cervical vertebra bilaterally and in the left lamina of the 7th. There was no displacement of the vertebral bodies, but a brownish discoloration of the dura was observed suggesting a minimal amount of old hemorrhage. The dura was incised in the mid-line and the arachnoid cut laterally. The dentate ligaments, which were taut, were sectioned bilaterally at three points, and upon retracting the cord medially and cutting the anterior surface of the dura a freely lying, fragmented nucleus pulposus was found extruded at the 6th and 7th interspace (Fig. 2). These fragments were removed with the aid of an incision made in the dura anteriorly on the opposite side of the canal and the interspace was thoroughly curetted bilaterally to remove any other loose tissue. The cord was of average consistency and showed no evidence of trauma or degeneration. Since there was no swelling of the cord after removal of the disk, the dura could be closed, and the remainder of the wound was sutured in layers.

Course. Eleven days postoperatively the patient began to move his legs and in another week began to recover some bladder control. On October 13 the Crutchfield tongs were removed, a plaster collar was applied, and the patient was removed from the Stryker frame. On November 12 he was transferred to Crile Veterans Hospital, Parma, Ohio for convalescent care, and with good physiotherapy he gradually improved.

On Aug. 11, 1950, approximately 2 years after his injury, the patient presented the pattern of a modified Brown-Séquard syndrome. There was good strength in the right extremities, but there was weakness in the flexors and lateral interossei of the left hand and in all movements of the left lower extremity, particularly in plantar flexion and dorsiflexion of the left foot. Hypesthesia persisted on the right from the L2 through the S5 segment; otherwise there was no abnormality in any sensory modality. The abdominal and cremasteric reflexes were normal on the right,
but absent on the left. Bilateral pyramidal tract signs were observed in the upper and lower extremities, markedly positive on the left and minimal on the right. Bladder control was good except in the morning when there was some urgency. Constipation was controlled by catharsis. The patient wore a low kick-up spring brace for his partial left foot drop and was able to get about for short distances without support. Most of the time he carried a cane which aided him in maintaining balance. The patient is a nurseryman and stated that he could supervise the care of his sixty-four acres, although he does tire easily. He assured the author that he is still continuing to improve from month to month even at this late date.

Fig. 2. Case 1. The 7th, 6th and 5th cervical nerve roots are exposed, and an extruded nucleus pulposus (arrow) is seen protruding through an incision in the anterior surface of the dura between the 6th and 7th nerve roots.

Comment. It is believed that the symptoms in this acute case may be explained on the same basis as the chronic cases of protruded nucleus pulposus described by Kahn, and by Bucy et al. On lumbar puncture there was no block and when pantopaque was introduced it passed rapidly upward through the cervical region without being sufficiently pooled to give a satisfactory visualization of the area; so the diagnosis of extruded nucleus pulposus was made preoperatively on the basis of neurological signs alone. It is our feeling that this patient should have been operated upon sooner and perhaps his convalescence and recovery would have been more rapid and complete. As a result of this experience we were on the alert for any case that presented a similar neurological pattern.
Case 2. R.C., 21 years, white male, a college football player, charged into the line during a game on Nov. 13, 1948, and suffered an injury to his cervical spine. The patient stated that he had immediate numbness from his neck on downward, including his hands. He could move his upper arms, but had paralysis of his hands, trunk, and lower extremities. He was transferred to Crile Veterans Hospital, Parma, Ohio on the evening of his injury.

Examination. There was hypesthesia at the level of the C6 dermatome bilaterally. Touch was preserved over the entire body, but there was a loss of approximately fifty per cent of vibration sense. There was complete areflexia, with paralysis of lower extremities, and inability to extend the arm at the forearm and to flex and extend the fingers of both hands. Roentgenograms of the cervical spine showed a severe compression fracture of the 5th cervical vertebra with some displacement of the body posteriorly (Fig. 3). The anterior-posterior view showed no abnormality. The neurosurgical resident reported the neurological and roentgenographic findings by telephone, and it was suggested to him that the slight posterior displacement of the body of the vertebra could cause the symptoms, but that a herniated disk at the 5th and 6th interspace could not be excluded as a possibility. On lumbar puncture the CSF was under normal pressure, clear and colorless, with no evidence of block on the Queckenstedt test. A myelogram was regarded as inadvisable for fear of causing further damage to the cervical cord. Crutchfield tongs were applied to steady the head and apply traction.

Operation. About 20 hours after injury a laminectomy of the 4th, 5th and 6th cervical laminae was performed. There was a depressed fracture of the 5th cervical lamina bilaterally with about 4 mm. depression on the right side, but apparently there was little or no compression of the dura and cord. The dura was opened in the mid-line and the arachnoid incised laterally. The cord was of average consistency without evidence of contusion, but was displaced posteriorly. The dentate ligaments were extremely taut. Upon sectioning three ligaments bilaterally the cord could be retracted to either side readily. When the dura was incised anteriorly to the left of the cord, an extruded disk was found lying fragmented in the canal with several pieces of bone attached. A slightly elevated bony ridge was also observed posteriorly. The interspace was thoroughly curetted in order to remove all loose tissue. A No. 10 rubber catheter was lubricated and then passed in either direction in the subarachnoid space without encountering any resistance, and the spinal fluid flowed freely. The arachnoid covered the cord.
in the mid-line, and the dura was left open in order to prevent constriction of the cord. Gelfoam was placed over the aperture in the dura and the wound closed in layers. The patient was then replaced upon the Stryker frame in traction.

Course. There was gradual improvement so that by Dec. 7, 1948 slight voluntary movement was present in the lower extremities. On Jan. 17, 1949 tidal drainage could be discontinued, and by April 1949 the patient could walk a short distance without support. On Aug. 11, 1950, 21 months after injury, the patient was able to drive fifty miles alone to keep the appointment for the examination. There was hypesthesia to the level of the D7 dermatome on the right, but otherwise there was no sensory impairment in any modality bilaterally. Some weakness was found in the interossei of the right hand, in the grip of the right hand, and all movements of the right lower extremity. The abdominal and cremasteric reflexes were absent bilaterally. There was some increase in tonus of the lower extremities. A prominent Hoffmann reflex was observed on the right with only a slight response on the left. Marked bilateral Babinski signs were obtained. The patient walked well with double upright braces, but the right lower extremity was weak, and his partial foot drop was somewhat incapacitating. He could walk on flat ground without aid, but still felt insecure without his cane and braces. The bladder status was satisfactory except for some urgency and dribbling in the early morning. The patient has been able to carry out a program of 24 semester credit hours of study during the past year and was graduated from college as an education major. He plans to continue with his career of physical education instructor and stated that he was still noting considerable improvement in his condition even from one week to the next.

Comment. Because of the experience with the first case the diagnosis of a ruptured nucleus pulposus was immediately suspected, and as a result the second patient was operated upon as an emergency. The latter had a more rapid recovery. Perhaps the injury was less severe with a slighter contusion to the cord, although the x-ray showed much more bony damage, but earlier operation may also have played an important part in the recovery.

DISCUSSION

The treatment of cervical spine injuries with cord involvement has been, and still is, one of the most controversial topics in neurosurgery.1,4,6-12,14 The percentage of salvage in this group of patients is not great, but there must be an active approach to the problem if there is to be any hope of improving our morbidity. A cervical cord injury ought to be regarded as an acute surgical emergency. The patient should be examined early, and, if proper indications are present, should be operated upon immediately. The cord does not tolerate acute compression for any length of time, because edema, anoxia, and irreversible changes soon occur.

In the past in cervical cord injuries attention has been paid to the spine and cord, but there have been relatively few observations on acutely herniated disks or on taut dentate ligaments. The author believes these factors may play an important part in the production of symptoms and the ultimate prognosis in certain cases.

There is, of course, practically universal agreement that a patient with
an immediate complete lesion, both sensory and motor, without a block on Queckenstedt test, should not be subjected to operation unless an attempt is being made to achieve a more satisfactory alignment of the spine. In the latter situation, this is of an elective rather than an emergency nature.

A year ago the author\textsuperscript{18} published a paper on herniated disk with immediate complete paralysis, and listed 5 indications for early operation in acute spine injuries:

1. A history of progression of neurological signs.
2. Compound fractures of the spine, particularly those patients with spinal fluid leaks.
3. Marked encroachment of bony fragments upon the spinal canal as exhibited in the roentgenograms.
4. With a lumbar puncture needle in place, evidence of complete blockage of the spinal fluid on jugular compression.
5. Evidence of blockage of a column of pantopaque upon myelogram examination in those cases which, in spite of a negative Queckenstedt test, have a definite sensory level.

As a result of the study of the 2 cases presented in this article it is believed a 6th indication should be added to the list:

6. Immediate complete paralysis with hypesthesia to the level of the lesion, but preservation of touch throughout the body.

Critics of the 6th point might maintain that since the lesion in these cases was an incomplete one, the patients would have recovered on a conservative regime. However, when one reviews the cases presented in the literature one is struck by the disabling residual neurological symptoms resulting from chronically protruded disks. To prevent this, the disk should be removed in the acute phase when it is fragmented and before calcification has occurred, for the latter frequently makes removal of this structure an impossibility. A fracture dislocation, with slight posterior displacement of the vertebral body, or possibly even a marked edema of the cord anteriorly from the recoil of a rebound disk, apparently can cause sufficient anterior compression of the cord for the development of the syndrome which has been described. This condition may be treated by aligning the spine with traction and then decompressing the cord by laminectomy, incising the dura, and sectioning the dentate ligaments bilaterally at three or four points.

\textbf{SUMMARY}

Two cases of acute cervical spine injury are presented in which a syndrome is described consisting of immediate complete paralysis with hypesthesia at the level of the lesion, but with preservation of touch and the retention of part of vibration sense. A ruptured nucleus pulposus was diagnosed preoperatively in both instances and found at operation, although this was in conjunction with a compression fracture of the cervical body in the second case.
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The mechanical stress concept first described by Kahn in his presentation of the role of the dentate ligaments in chronic anterior cord compression is the basis on which it is believed the symptoms in these 2 cases may be explained.

The indications for early operation on cervical cord injuries are listed and the acute dentate ligament syndrome described herein is included as an additional criterion for early operative intervention.

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REFERENCES