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Classification of Cervical Cord and Root Injuries Based on Neurological Symptoms

by

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Cervical cord and root injury is becomming a more and more common accident amoung all kinds of traffic, industrial and sport accidents. The injury is serious because of the involvement of functions of the upper exremities, especially of hands. On many occasions the classification and mechanism of injury in the cervical vertebrae have been the subject of both discussion and study (BEATSON 1963, HOLDSWORTH 1963, BAILEY 1963). But there are relatively few studies on the neurological symptoms of the injury. In my opinion, however, the neurological involvements are more important than fracture or dislocation in the cervical region, because, for example, there is severe cord injury even without noticeable fracture or dislocation. If these patients are evaluated carefully from neurological symptoms and treated early, there may be more chances of restoration of the functions of extremities. The aim of this paper is to find the relation between the neurological symptoms and the responses of the symptoms to the various treatments.

CLINICAL MATERIAL

During the past 3 years 37 patients with the cervical cord and root injury were treated in our hospital. Three cases had complete transverse lesion and the rest of the cases had incomplete lesions. The patients with complete lesion died between a week and 5 months. According to the types of nerve involvement, the patients with incomplete lesion showed various degrees of improvements by treatments. Mechanism of injury was difficult to determine in many cases. Based on the memory of patients and skin wounds around the head, the mechanism of injury has been estimated that 8 cases had hyperflexion, 6 cases had hyperextension and 4 cases had rotation. In the rest of the cases, the mechanism of injury was unknown. One patient with complete lesion showed dislocation between the sixth, and the seventh, cervical vertebrae, 8 cases showed subdislocation of less than one third of vertebral width, and the rest of the cases showed no radiological evidence of fracture or dislocation. Radiological examination of the cervical spine disclosed the high incidence of spondylosis. In 21 cases definite radiological changes of spondylosis were observed. As already pointed out by TAYLOR and BLACKWOOD 1948, it is evident

that the presence of spondylosis playes an important role in producing cervical cord and root injury by the slightest trauma.

NEUROLOGICAL SYMPTOMS

Type 1 Transverse lesion was found in 3 cases. In one case there was severe dislocation between the sixth, and the seventh, cervical vertebrae and in the other 2 cases no radiological evidence of fracture or dislocation was observed. Decompression laminectomy was done on 2 cases and reduction of dislocated vertebrae was done by an anterior approach on one case. As mentioned above, they died between a week and 5 months.

Type 2 This is more common in all 4 types and 17 patients belong to this type. In this group, sensory and motor changes appeared not only at the injured level but also below the level of injured segment. Another characteristic of this type is variety of neurological changes in severity. The onset of neurological symptoms delayed in 8 patients. In one patient neurological symptoms developed 10 years after the accident. The patient had the fractured odontoid process without symptom and one day a school teacher pushed him back by pressing his forehead by a hand. The patient developed spasticity in the lower extremities and came to our hospital with the chief complaint of difficulty of walking. The pre- and post-operative X-ray pictures are shown in Figure 1. After the posterior fusion the difficulty of walking disappeared. In the other 9 patients, symptoms

Fig. 1

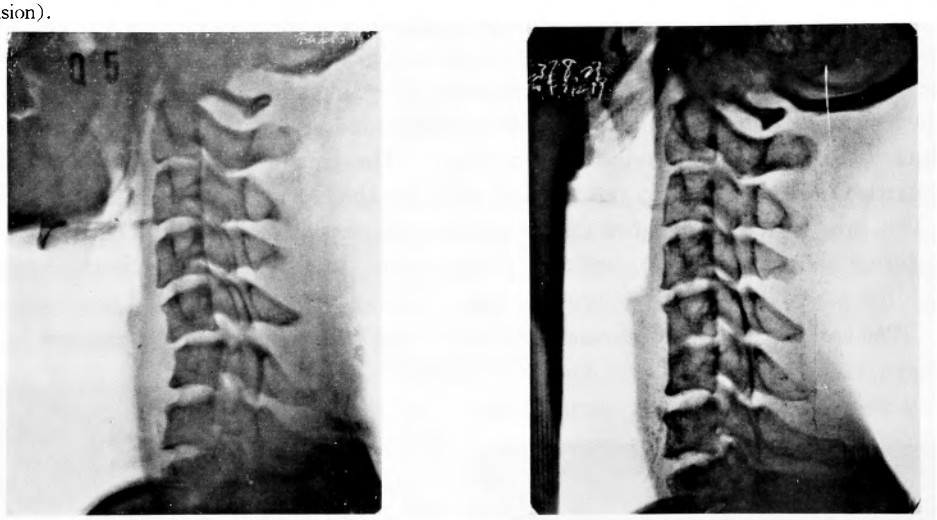
Pre- and post-operatives X-ray pictures of type 2 cervical injury with late onset of symptoms (posterior fusion).

developed immediately after the accidents and after an interval the symptoms became stabilized. The following is a typical case of this type. A 19 year-old male was thrown on his face during Judo training. On arrival to a hospital, the both upper and lower extremities were completely motionless and numb. Skull traction was applied and a week later all voluntary movements of extremities were recovered. The patient was admitted to our hospital 4 months after the accident with chief complaints of difficulty of gait and

urinary retension. On admission, X-ray revealed subdislocation at the level between the fifth, and sixth, cervical vertebrae. Physical examination revealed that the patellar and Achilles tendon reflexes were accentuated and the patellar and foot clonuses were positive. Pain and touch sensation were decreased at the area below the sixth thoracic dermatom. There was no noticeable neurological changes in the upper extremities. He had frequent episodes of fever because of urinary tract infection. The patient was treated by interbody fusion through an anterior approach. The pre- and post-operative X-ray picture are shown in Figure 2. All neurological symptoms disappeared postoperatively. In this group of

Fig. 2

Pre- and post-operative X-ray pictures of type 2 cervical injury (anterior decompression and interbody fusion).



patients, the level of sensory change was usually below the segment corresponding to the cervical spine injury. Pyramidal signs, such as clonus and exaggerated tendon reflexes, existed on the lower extremities and pathological reflex did not exist in the upper extremities. But in a few cases, symptoms caused by nerve root compression superimposed on the above mentioned typical neurological changes. The decreased muscle power, wasting of the muscles and changes of skin sensation in the arms may mislead us to classify this type as type 3. In contrast to the neurological changes in the type 3, these root compression symptoms respond to treatments favorably. Skull traction and the removal of disc followed by an interbody fusion produced marked relieve from the symptoms.

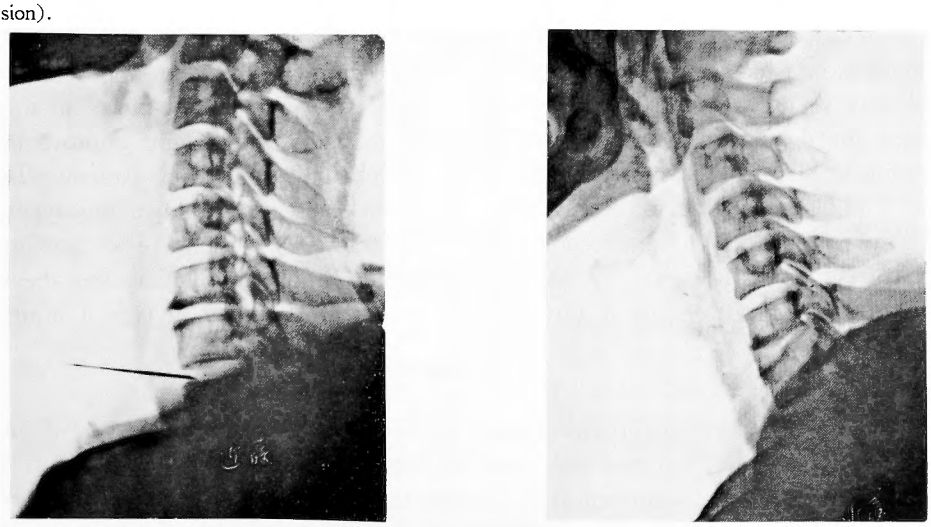
Type 3 This is the type of cord injury described by SCHNEIDER on many occasions (1954, 1958) as "Central cord injury". The patients in this group usually show more marked neurological changes in the upper extremities than in the lower extremities. The following case is an example. A 70 year-old male fell down from a tree and his head and neck were struck by the ground. Immediately after the accident, he noticed that his both upper extremities were numb and motionless. Numbness was also noticed on the abdomen and the lower extremities. On admission, physical examination revealed that the

biceps reflex was normal, the triceps reflex was weak, abdominal reflex was absent, the cremaster, Achilles and patellar tendon, reflexes were absent. Cratchfield tongs was applied and muscle function of the lower extremities recovered itself quickly. One month after the accident, sensory disturbance was proved on the area between the fourth cervical, and the tenth thoracic, dermatomes. Marked reduction in muscle power was noticed on the shoulders, arms and hands. Interbody fusion was carried out through an anterior approach on the C 4-5 and C 5-6 level. After the operation, sensory disturbance disappeared and muscle function of the shoulders and the arms recovered itself. Movement of the fingers was still markedly limited. The patients with typical symptoms of central cord injury are relatively few. In our group of patients, only 4 out of 37 patients belong to this group. The response of this group patients to surgery is not favorable. Symptoms in the hand and arm are caused not only by the central cord damage, but also by the compression of nerve roots at the intervertebral foramen. The removal of the disc, the posterior osteophyes, and the widening of inter-vertebral foramen by Croward technique (CLOWARD 1959) improved the functions of hand and arm. The decompression laminectomies have been performed on one case and the effect of the surgery was not noticeable.

Type 4 This is a type of patients with mostly root compression symptoms. The injury is caused mostly by slight trauma and prognosis is good. In this series, 13 out of 37 cases belonged to this type. The following is an example. A 50 year-old male fell down a 4-meter height and lost consciousness for about 10 minutes. After he regained consciousness, he noticed the both upper extremities were paralysed and the neck was immobile. On admission, he had no voluntary movement in the both hands, but no neurological changes were noticed on the lower extremities. Cratchfield tongs was applied for 2 weeks without further improvement. Anterior decompression and interbody fusion was performed by Croward technique at the C 6-7 level. After the surgery, the function of hands were restored. The pre- and post-operative X-ray pictures are shown in Figure 3. Two patients

Fig. 3

Pre- and post-operative X-ray pictures of type 4 cervical injury (anterior decompression and interbody fusion).



out of 13 were treated by skull traction alone, with satisfactory result. The rest of the cases were treated by skull traction followed by the anterior decompression and interbody fusion by Croward's technique. In most cases, sensory changes, such as decreased touch and pain sensation, existed on the same level as motor weakness, and in a few cases, radiating pain co-existed. In some cases, it was difficult to differenciate this type injury from root avulsion. Negative myelographic illustration of pooling of radiopaque substance in the nerve sleeve is not necessarily the evidence of root compression. Positive head compression test, neuralgia and discography help to confirm the existence of root compression.

INDICATIONS FOR SURGERY

We have performed 23 anterior interbody fusions and 4 laminectomies, on 37 patients. One patient had a decompression laminectomy 24 hours after the accident, and an anterior interbody fusion 2 years later. Posterior fusion alone was employed only on the case of odontoid process fracture. The indications for early decompression laminectomy had been discussed elswhere by neurosurgeons (LINDSTROM and POWELL 1957). In our series, the patients came in the hospital much too late and consequently the laminectomies had to be performed more than 12 hours after the accidents. We are in no position to make any definite comments on the indications of early decompression laminectomy. Our four cases of laminectomies only proved that the procedure delayed more than 12 hours after the accidents was not effective. In contrast, the anterior interbody fusion accompanied by the removal of both protruded disc and osteophytes showed definitely favorable effects in neurological symptoms. In the patients of type 2, various improvements were noticed after the operation. In some cases, pain and touch sensations were recovered, in some cases, the accentuated tendon reflexes and the clonus of foot and ankle disappeared, and in some other cases, feeling of tightness around the chest disappeared. The effect of this procedure in type 3 patients were not remarkable. In all 4 cases, however, definite improvement was obtained on the fnction of the hands. We presume that the improvement resulted from the decompression of nerve roots. Although the main lesion of this type may be located in the central part of the spinal cord, there are always an accompanying nerve root compression which can be released by anterior decompression. The improvement thus obtained may be only flexion or extension of fingers, or may be less. Since, in this type of injuries, the dysfunction of the hand are main disability, any slight improvements in the function of the hand have great meaning for the rehabilitation of the patients. Because the type 4 injury is a kind of cervical disc syndrome caused by trauma, this type is the best indication for an anterior decompression and interbody fusion. The late onset of neurological symptoms as seen in a few cases of type 2 injury also rationalizes the use of interbody fusion for prevention of further development of symptom in type 4 injury.

DISCUSSION

By studying 37 cases of cervical injuries, we have found that the neurological involvement can be divided into 4 types and that the types correspond to the response of the symptoms to treatments. Neurological symptoms can be roughly divided into 2 groups; namely, the nerve root imvolvement and the spinal cord involvement. The type 4 mainly

consists of the nerve root involvement. The other 3 types consist of the nerve root, and the spinal cord, involvements in various proportions. The spinal nerve can be involved at many levels, namely at the level of nerve cells, at the anterior or posterior roots, in the inter-vertebral foramen and also at the more peripheral level. Involvements can be caused by many different ways. If nerve cells are injured by pressure or decreased blood supply, the neurological change may be irreversible. If the nerve is only compressed by protruded cervical disc or by the unstable facet, the nerve function can be restored by the decompression procedure. If nerve fibers are torn at any levels, the restoration of function is difficult and reconstructive measures of the hands should be considered. Fortunately, we have found by the experience of anterior decompression and interbody fusion that many cases of neeve root involvement in the cervical injury are caused by compression due to the disc, facet or osteophytes and, therefore, nerve function can be restored. On the other hand, the spinal cord involvement presents a difficult problem. The central cord damage caused by hemorrhage into the cord may be irreversible and nothing can be done except reconstructive surgery of the hand. KAHN (1947) mentioned that pressure on the anterior part of the cord by a bulging disc could be the cause of neurological changes on the trunk and lower extremities. The pressure could be transmitted to the corticospinal tract by traction through the dentate ligaments, thus, in severe cases, causing exaggerated tendon reflexes, clonuses of the ankle and the patella and spastic paralysis. This explanation of mechanism of cord involvement is not confirmed, but the symptoms such as SCHNEIDER (1955) called "Anterior cord syndrome" really exist. The type 2 in our classification corresponds to this syndrome. The anterior decompression and interbody fusion to this type of anterior cord compression is very effective. Accentuated tendon reflexes and decreased pain and touch sensation disappear after the surgery.

As mentioned already, in many cases, spondylosis is a predisposing factor for the cervical cord and root injury. Spondylotic spur formation on the posterior vertebral margin and the Luschka joint may exist without causing any neurological symptoms on the arms and legs for many years. When those patients received hyper-extension, hyperflexion or forced rotation of the cervical spine, symptoms of cord or root compression may be initiated. Therefore, removal of the osteophyte followed by the interbody fusion is more rational procedure than laminectomy. In 8 cases, the neurological symptoms developed after a long asymptomatic period following the accident. The instability of vertebrae due to torn lateral, and torn posterior, ligaments complexes or the angulation of the spinal canal due to dislocation of the facet joint may be the causes of the delayed onset of symptoms. Indication of spinal fusion, either by an anterior, or a posterior, route, for these patients should be justified.

CONCLUSION

The cervical cord and root injury was classified into 4 types, according to the neurological symptoms. Type 1 is transverse lesion. Type 2 is the group of patients with neurological symptoms much below the injured segment. The symptoms are prominent mostly on the lower extremities and trunk. The severity of the symptoms differs according to cases. Type 3 is so-called central cord injury. The neurological symptoms are

more prominent on the upper extremities than the lower extremities. We found that a part of neurological symptoms on the upper extremities was caused by the nerve root compression and that improvement in the function of hand could be expected by the procedure of anterior decompression and interbody fusion. Type 4 is caused mostly by the nerve root involvement. In some cases, the symptoms can be cured by traction alone, while, in other cases, by the procedure of anterior decompression and interbody fusion.

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和文抄録

頸髄損傷の神経学的分類

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過去3年間に当科を訪ずれた頸髄損傷は，37例でこれらを詳細に神経学的に診断し，種々なる外科的療法をおこなつた．その結果，頸髄損傷をその神経学的症状から4型に分類すれば，予後および治療に対する反応とよく対応することがわかつた．第1型は横断麻痺で，予後の悪いものであるが，3例にすぎなかつた．第2型は一番多いもので17例であつた．知覚ならびに運動麻痺が受傷した髄節より下にあるもので，上肢よりも軀幹，下肢の症状が著しいものである．第3型はいわゆる中心性損傷といわれるもので，上肢において，下肢よりも著しい神経症状を呈する．第4型は，上肢にのみ神経症状を有し，牽引，除圧手術により完全に治るもので，13例がこの型に属した．