Prognosis and Management of Spinal Cord and Cauda Equina Bullet Injuries in Sixty-Five Civilians

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The purpose of this study of patients with spinal cord injury was to isolate a single wounding agent, namely, bullets, and to discuss in detail one aspect of the problem, the efficacy of surgical therapy. On the basis of this analysis certain predictions as to outcome can be made and a degree of uniformity introduced into the management of this type of spinal cord injury.

Material and Methods

The data in this study have been gathered from 42 patients with civilian bullet injuries of the spinal cord and 23 patients with similar wounds of the conus medullaris and cauda equina. These patients were admitted consecutively after 1955 to three facilities with which the authors were associated, and 25 were under their personal care. The remainder were identified from the archives of the various institutions and then traced for follow-up. Each individual had a single bullet wound of the spinal cord or cauda equina; other types of spinal cord or cauda injuries were not included. All patients had an initial neurological deficit, which was in most cases profound. Patients had anteroposterior and lateral x-rays of the spine and usually antibiotics and tetanus prophylaxis. The familiar general problems related to acute spinal cord injury and paraplegia have been discussed in detail in other publications and will not be emphasized in this paper.

The patients were separated into four clinical groups according to the spinal cord deficit:

Group 1. Immediate clinically complete loss of function of the spinal cord above the conus medullaris

Group 2. Clinically incomplete spinal cord signs which were non-progressive

Group 3. Progressive spinal cord deficit

Group 4. Injuries of the conus medullaris or cauda equina with an initial neurological deficit.

All cases were followed for 6 weeks, and many for 10 years or more. Follow-up periods were generally felt to be sufficient for purposes of determining gross return of function.

Results

Group 1: Immediate Complete Loss of Spinal Cord Function. Thirty-five patients were judged to have had immediate, and clinically complete, loss of function of the spinal cord above the conus medullaris. There were 31 men and four women, ranging in age from 14 to 56 years, with an average age of 27 years. The initial clinical level was C-5 in two patients, C-7 in two, C-8 in two, T-1 in four, T-3 in four, T-4 in five, T-5 in one, T-6 in seven, T-7 in three, T-8 in one, T-10 in three, and T-11 in one. Satisfactory lumbar punctures were performed in 20 patients. Ten had a complete block, one a partial block, nine no block. In 14, the fluid was grossly bloody. Laminectomy was performed in 24 cases: 11 were operated on within 6 hours of injury, three within 12 hours, two within 36 hours, and eight after more than 72 hours. In 33 patients, the bullet wound of the cord was the only injury. In two, a second extraneural bullet wound was sustained. In 15 patients the single bullet traversed the chest, causing hemothorax or hemopneumothorax in all cases. Thoracot-
omy was not necessary in any, but tube drainage was instituted in most cases. All patients required immediate and continuous bladder catheterization, and in no instance was there any recovery of sphincter control during hospitalization.

Two of the 24 patients who had surgery had a small epidural hematoma and confused cord. Two others had fragment penetration of both dura and cord. Six patients had complete and three had partial transection of the cord. Two had only an edematous cord. In seven the cord was contused, while in two the cord appeared normal. All of these patients had been judged immediately paralyzed and had no significant return of function later.

In three patients the sensory level dropped three dermatomes within the first few days; two of these had a laminectomy and one did not. Many patients had a drop of one dermatome within a few days, irrespective of the type of therapy. Two patients, both of whom had laminectomy, recovered spotty sensation below the level of injury but motor and sphincter return was lacking. Despite minor neurological gains, no patients including those having laminectomy had recovered significant function by the time of transfer to a chronic care facility, although the recovery of a single root might be extremely important in rehabilitation.

Twenty-four surviving patients were traced from 3 months to over 6 years. The average follow-up was 24 months. There was no useful return of function in any patient in spite of laminectomy in 16. Many patients were returned to a useful existence and even “walked” by physiatic methods. Eleven patients, eight of whom had had a laminectomy, died within post injury ranges of 5 days to 5 years.

The presence or absence of spinal fluid blood, dynamic block, or dermatomal level of injury could not be correlated with survival even when divided into short-term or long-term categories. Trajectory and final position of metallic fragments or extent of bony fragmentation could not be correlated with survival. In a few instances, in spite of careful radiographic survey, fracture could not be detected but was found at laminectomy. Also, in some patients the trajectory indicated that the spinal canal had not been transgressed by the missile. In these cases shock waves were presumed to have caused the permanent neurological dysfunction, although it is possible that deflection of the bullet may have occurred and the straight line between the radiographic location of the metallic fragment and the area of entrance may not represent the true trajectory. Wounds were presumably inflicted by pistols with calibers ranging from 0.22 to 0.45 inches.

**Group 2: Incomplete Spinal Cord Signs.** Five patients, all male, ranging in age from 10 to 44 years (average age, 22.2 years), had nonprogressive neurological loss with partial sparing of motor and sensory function below the level of spinal cord injury. One patient had slight damage initially, with little recovery; he had weakness of the right leg but could walk, sphincter tone was normal, and there was hypesthesia between T-8 and T-12. The main bullet fragment was recovered extradurally. After 1 year, only weakness remained.

The remaining four patients in this group had severe deficits. The levels of injury were T-4, T-5, T-7, T-9. All retained a slight degree of sensory or motor function below the level, but sphincter function was absent. In the three in whom lumbar puncture was performed, the fluid was bloody and one showed a manometric block. In the two who had laminectomy, the cord was found confused. One of the nonlaminectomized patients had received a total of six bullet wounds causing hemopneumothorax and a penetrating abdominal injury. At the end of the follow-up period of 3 months to 2 years, almost no recovery of neurological function had taken place, although sparing below the level of injury remained.

**Group 3: Progressive Neurological Deficit with Spinal Cord Involvement.** There were two men with progressive neurological loss. The first, aged 40, walked immediately after the bullet injury. Over the next 2 hours all function below T-8 was lost except for a cremasteric reflex. Laminectomy showed a confused spinal cord corresponding to the clinical level. The patient died of complications 6 months later, without return of function.

A second patient, aged 33, with a severe