

The military medical management of missile injury to the spine: A review of the literature and proposal of guidelines

N Buxton

ABSTRACT

The management of missile injury to the spinal cord is controversial. The literature is reviewed and recommendations made about the management of these injuries. To surgeons in a country that is relatively safe such injuries are rare, this review provides useful information about this condition.

Introduction

Wartime experience of the management of missile injuries to the spine has shaped how they are now dealt with (1-9). This paper will review the findings from wartime and civilian experience with this devastating injury and present a plan for the management of such casualties. The need for such a review is the lack of experience that we in the UK have in dealing with gunshot wounds (GSW) to the spine when compared to other more violent cultures. It is this lack of baseline experience that may cause us as surgeons to act inappropriately in ignorance of what has been established by other's often bitter experience.

Historical perspective

Lord Nelson appears to be the first major figure to have been killed by a GSW causing spinal cord injury (SCI) (10,11) and it has been suggested that President JF Kennedy of the United States had such an injury from the first bullet (11).

Twentieth Century warfare experience has separated the management into a number of epochs. In World War I (WWI) the rationale was to perform delayed surgery, only on those with incomplete injuries whose neurological status was deteriorating (11). In World War II (WWII) the perception changed to operation on all patients to decompress and debride in order to improve neurological status and minimise the risk of infection (1, 2, 12); the emphasis turning to care of the urinary tract and prevention of decubitus ulcers in survivors (2). By the Korean War the emphasis had barely changed with decompression and debridement for all after definitive management of their other injuries, care to avoid decubitus ulcers and early mobilisation in braces starting as early as day 10, if

possible (3). The experience of the Vietnam War (4) was that with rapid evacuation to aggressive resuscitation and definitive surgical care morbidity and mortality improved but not neurological function, with or without surgery. The outcome continued to reflect the neurological status at presentation.

In the Iran-Iraq War it was felt that surgical exploration did not improve outcome (8); indeed surgery increased complication rates. Recent Balkan experience, where evacuation times to definitive surgical facilities were similar to those in the Vietnam War, showed no startling improvements, despite the availability of modern imaging techniques (13). They found that conservative management yielded good results, limiting surgery to those with cerebrospinal fluid (CSF) leaks, root pain, progressive neurological deficit and spinal instability, again confirming that presentation neurological status determines the outcome (6, 7, 9). Lebanon experience found that the most important factors for determining outcome were an early assessment of neurological status and a thorough rehabilitation programme (5).

Epidemiology

In the civilian setting in the United States (USA) GSW SCI is the second (14, 15) or the third (16-20) most common cause of SCI. This constitutes between 12-15% of all SCI (10, 16) although one source suggested 25% of all SCI were due to GSW (14). By comparison during a similar period 28% of SCI were due to road traffic accidents and 16% due to falls (6). More than 90% are males (15, 21), average age reported as 29.7 years (22) and, probably not surprisingly in the urban USA setting, 37% are under the influence of drugs, 26% of alcohol (10) and 40% are shot from behind (22). In Croatia 0.9% of all those injured by firearms had spine or spinal cord injury, with 55% of SCI being due to low velocity shell fragments (23).

One series reported 62% with complete paraplegia (8) whereas others suggest 29% have complete paraplegia, 28% incomplete quadraparesis, 23% incomplete paraparesis and 19% complete quadraplegia (16, 24). Associated injuries are seen in high percentages ranging from 25% to 100% (3,

Maj N Buxton
MB ChB
FRCS(Ed)(Neuro.Surg)
RAMC(V)
RMO
The 4th Battalion,
The Parachute Regiment
Specialist Registrar,
Dept of Neurosurgery,
University Hospital,
Nottingham NG7 2UH
E-mail:
neilbuxton@doctors.org.uk

6, 9, 10, 21-23, 25-27). The level of injury varies between 19-27% for cervical, 30-54.5% for thoracic (80% of whom are complete (28)) and 19-33.5% for lumbar (7, 8, 15, 23, 28-30).

Simple ballistic implications

Most modern military injuries are due to small fragments; these are generally low velocity projectiles, and are less likely to cause SCI than high velocity military weapons (31).

With modern high velocity weapons a direct hit on the spinal cord is not required to cause devastating injury (11, 32-37). Indeed, experimentally, subdural haematoma along the whole length of the spinal cord can be achieved by hitting a spinous process with a high velocity projectile (35). Microscopic damage to the spinal cord is not confined to the level at which it is hit, with injury to cells being seen up to 15 cm from the level of primary injury (35).

Management

Resuscitation:

As many of those injured have other injuries, basic life saving principles apply from the point of wounding back to the Regimental Aid Post (RAP) using tried and tested BATLS/ATLS protocols (10). As part of the overall resuscitation the victim will need all life threatening injuries treated prior to consideration of his/her SCI (4,7,10,29,38-40). Zipnick (40) believes that spinal shock (hypotension and bradycardia) is rare in this type of injury and that hypotension must always prompt the search for bleeding from other injuries. In one series the mortality of 5% was due to the associated injuries (23) whilst others reported 4.2% (9). This is clearly an improvement over the 71.8% mortality that Cushing found in WWI (41).

After resuscitation, stabilisation and treatment of other injuries the evacuation chain may mean that it is sometime before a neurosurgeon sees the patient for assessment. Early assessment of the neurological status is deemed vital and should be carried out within 24 hours of the injury, after resuscitation, as the neurological and autonomic status has considerable implications for prognosis; assessment prior to resuscitation may give spurious results and delay treatment for life threatening injuries (5, 7, 22, 31, 38).

The third North American Spinal Cord Injury Study (NASCIS III) advocates the use of methylprednisolone (MP) in the management of blunt SCI (42). Levy *et al* (43) found the MP did not significantly improve the functional outcomes in GSW SCI, despite experimental evidence to the contrary (44). However, Isiklar (31) suggests that it may be indicated. The use of MP has been implicated in an increase in complications in these injuries (45) and may

even impair recovery (46). However, Aarabi in the Iran-Iraq War (8) routinely used dexamethasone.

Bladder catheterisation and measures to prevent decubitus ulcers and deep venous thrombosis are required early to maximise recovery (2, 3). This has implications for the intensive nursing of such patients. It is highly recommended that repeat examination from head to toe is undertaken periodically to minimise missing associated injuries (3).

Imaging the SCI:

Plain X-ray will demonstrate bone anatomy and presence and position of retained foreign bodies. For more detailed bone anatomy computerised tomography (CT) can provide good detail (13,31) which may require a mobile CT scanner with CT myelography, spiral and 3D reconstruction capability in the field.

Magnetic resonance imaging (MRI) is very useful for soft tissue appearances, especially of the cord itself. Early realisation that the cord is completely transected, for example, has enormous prognostic implications. However, MRI can cause FB movement and the FB may cause significant artifact although such patients have been imaged safely (47).

Prior to the exploration of neck injuries affecting the cervical spine angiography is recommended, especially for the vertebral artery anatomy (31).

Instability:

In blunt SCI, protocols such as ATLS are well established for treating such injuries as if they are unstable. However, on the battlefield such management may not be necessary as it is generally felt that war missile injuries to the spine do not result in instability (5,11,26, 31). Instability may be iatrogenic after decompression laminectomy (48,49), the facet joints must be preserved where possible. Treatment of an unstable spine will be discussed below.

Whilst some advocate that such injuries should be treated as if they are all unstable (31) this may actually be detrimental to the casualty. A recent review of penetrating neck injuries stabilised by a collar (50) found that the collar masked deterioration and other injuries and was not, in fact, needed as the spine was not unstable. They recommend avoiding the use of a stabilising collar in all such injuries.

Operation?:

Controversy exists regarding whether or not to decompress the spinal cord or theca. The most important factor for overall outcome is the initial neurological status. With this in mind there have been attempts to improve the neurological prognosis in all grades of SCI by decompressive laminectomy and removal of any FB impinging upon the cord

or theca. This rationale is largely based on protocols promulgated from WWII experience carried into Korea and Vietnam (1-4, 12, 28, 51, 52).

More recent experience with this type of injury in the civilian setting has brought about a change in the management, tending towards the conservative (21, 29, 48, 49, 53). Modern military experience has reflected this (5, 6, 8, 9).

However, Waters (28) did feel that, in incomplete injuries only, bullet removal improved overall motor function at 1 year from injury and Jallo (22) and Splavski (7) also recommend operative decompression. What has been found in these series (5, 6, 8, 9) is that with or without surgery, in complete or incomplete SCI, laminectomy and/or removal of FB does not actually improve the neurological status. What has been seen, unfortunately, is that some series have worse complication rates for the surgical cases than non-surgical (26, 27, 49, 54, 55). For lesions involving the cauda equina this is not necessarily the case. Many series have shown that removal of FB from the cauda equina improves neurological outcome (8, 28, 29, 49, 56). During surgery for the removal of the FB from the cauda equina finding the FB can sometimes be a problem as they can migrate (57-62) and having the patient slightly head up with fluoroscopy is recommended (63).

There is widely held agreement over spinal surgery for progressive neurological deficit, instability (up to 22.2% in one series (9), and closure of CSF leaks (64).

Removal of the FB to prevent future infection is controversial. Many feel that FB retention does not increase the risk of sepsis, especially if treated with high dose antibiotics for more than 7 days (2, 39, 54, 65-69). Injuries penetrating other viscera causing SCI occur in a high percentage of cases (25, 26) and thorough wound washout from anteriorly, coupled with prolonged high dose antibiotics, is recommended to reduce the risk of spinal infection especially in transperitoneal injury (39,68); those penetrating the colon appear to be at greatest risk of causing infection (69).

Retained FB can cause long term non-infectious problems. Lead poisoning secondary to GSW is well recognised with a case of disc space involvement with a latency of 12 years being reported (70). Copper jacketed projectiles are particularly toxic and it is recommended that they are removed early (22). Interestingly, there is a report of cauda equina syndrome due to a retained bullet herniating into the spinal canal from a disc space 9 years after being shot (71). They can cause low back pain and radicular symptoms due to the long term reactive tissue development around the FB up to 17 years after the initial injury (72,73). Osteomyelitis has also been reported due to

retained FB (74).

Surgery to remove the FB for pain relief does not decrease pain in the early period of rehabilitation (15, 28), although in WWII McCravey (2) and Pool (1) felt that pain relief could be obtained by FB removal. More recently this has been echoed by Robertson (54).

Prognosis:

Remembering that neurological improvement occurs with or without surgery and best in cauda equina lesions (8) the prognosis largely depends on the whole care of the patient with care for pressure areas, bladder, nutrition etc. Carillo *et al* (10) felt that there was an overall decrease in life expectancy for victims of such an injury. Samsa (75), looking at military veterans found a similar long term reduction in life expectancy. Early death, despite modern management can be seen in approximately 4-5% (9, 23) and is usually due to other injuries. McKinley (76) found that, despite it being a potentially worse injury, SCI secondary to GSW had similar lengths of stay in rehabilitation facilities as blunt SCI, and also had similar functional independence measure scores and discharge home rates. Therefore, although appearing to be a totally devastating injury a return to a useful life can be achieved in many who survive the acute phase.

Management recommendations and conclusions

After resuscitation and arrival at the RAP the injured soldier needs to be assessed, stabilised and made ready for evacuation. Although the risks of the spinal injury being unstable are small they should be treated as such, but care should be taken not to mask the deterioration of neck wounds by application of a stabilising collar without constant checking to make sure that wound complications do not go unnoticed. Other life threatening injuries take priority.

With regard to surgery of the spine NATO guidelines (64) state that complete injuries do not require surgery and that surgery is indicated for progressive neurological deficit and spinal instability. To this I would add CSF leaks, delayed infection or FB reaction, presence of a copper FB or lead FB in a joint or disc space and radicular pain where the FB can clearly be demonstrated to be compromising the root.

The use of steroids cannot be recommended at this time due to the uncertainty about their efficacy in penetrating spinal cord injury.

Decompression laminectomy and FB removal for the sake of it can no longer be justified.

High dose broad spectrum antibiotics for more than 7 days are indicated especially if

the FB is retained or a hollow viscus is traversed.

The most important factor for prognosis is presentation neurological status, 90% of presenting neurological deficits being permanent (23).

Such an injury in wartime is very intensive on personnel and resources, but such injuries can be survived and, especially if incomplete, the patient may make some useful recovery.

References

1. Pool JL. Gunshot wounds of the spine. Observations from an evacuation hospital. *Surg Gynecol Obstet* 1945; **81**: 617-622.
2. McCravey A. War wounds of the spinal cord: A place for exploration of spinal cord and cauda equina injuries. *JAMA* 1945; **129**: 152-153.
3. Wannamaker GT. Spinal cord injuries: A review of the early treatment in 300 consecutive cases during the Korean Conflict. *J Neurosurg* 1954; **11**: 514-518.
4. Jacobs GB, Berg RA. The treatment of acute spinal cord injuries in a war zone. *J Neurosurg* 1971; **34**: 164-167.
5. Hammoud MA, Haddad FS, Moufarrij NA. Spinal cord missile injuries during the Lebanese Civil War. *Surg Neurol* 1995; **43**: 432-442.
6. Splavski B, Vrankovic D, Blagus G, Mursic B, Ivekovic V. Spinal stability after war missile injuries of the spine. *J Trauma* 1996 **41**(5): 850-853.
7. Splavski B, Vrankovic D, Saric G, et al. Early management of war missile spine and spinal cord injuries; Experience with 21 cases. *Injury* 1996; **27**(10): 699-702.
8. Aarabi B, Alibaii E, Taghipur M, Kamgarpur A. Comparative study of functional recovery for surgically explored and conservatively managed spinal cord missile injuries *Nuerosurgery* 1996; **39**(6): 1133-1140.
9. Jankovic S, Basic Z, Primorac D. Spine and spinal cord injuries; during the war in Croatia. *Mil Med* 1998; **163**(12): 847-849.
10. Carillo EH, Gonzalez JK, Carillo LE, et al. Spinal cord injuries in adolescents after gunshot wounds: An increasing phenomenon in urban North America. *Injury* 1998; **29**(7): 503-507.
11. Dickman CA, Golfinos JG. Penetrating Spinal Injury In *The Practice of Neurosurgery* (CD Rom version), eds Tindall GT, Cooper PR, Barrow DL 1996, Williams and Wilkins Baltimore ch 114.
12. Scarff JE. Injuries of the vertebral column and spinal cord in Brock S ed, *Injuries of the brain and spinal cord and their coverings*. 4th ed New York, Springer Publishing Company 1960: 739.
13. Splavski B, Saric G, Vrankovic D, et al. Computed tomography of the spine as an important diagnostic tool in the management of war missile spinal trauma. *Arch Orthop Trauma Surg* 1998; **117**(6-7): 360-363.
14. Hoshida GM, Garland D, Waters RL. Gunshot wounds to the spine. *Orthop Clin North Am* 1995; **26**(1): 109-116.
15. Oro J. Gunshot wounds to the spine. *Hyperbook of Neurosurgery* <http://www.neuroworld.com/hyperbook/neurotrauma/sci/gsw/1/html>, 2000.
16. Burney RE, Maio RF, Maynard F, et al. Incidence, characteristics and outcome of spinal cord injury at trauma centers in North America. *Arch Surg* 1992; **128**: 596-599
17. Kalsbeek WD, McLaurin RL, Harris BSH, Miller JD. The national head and spinal cord injury survey: Major findings. *J Neurosurg* 1980; **53**: 19-31.
18. Stover SL, Fine PR. The epidemiology and economics of spinal cord injury. *Paraplegia* 1987; **25**: 225-228.
19. Young JS, Burns PE, Bowen AM, McCutchen R. Spinal cord injury statistics: Experience of the Regional Spinal Cord Injury Systems. Phoenix Arizona Good Samaritan Medical Center, 1982.
20. Dincer F, Oflazer A, Beyazova M, et al. Traumatic spinal cord injuries in Turkey. *Paraplegia* 1992; **30**: 641-646.
21. Simpson RK, Venger BH, Narayan RK. Treatment of acute penetrating injuries to the spine: A retrospective analysis. *J Trauma* 1989; **29**(1): 42-46.
22. Jallo GI. Neurosurgical management of penetrating spinal injury. *Surg Neurol* 1997; **47**: 328-330.
23. Rukovansjki M. Spinal cord injuries caused by missile weapons in the Croatian War. *J Trauma* 1996; **40**(3): S189-S192.
24. De Vivo MJ (ed) Life expectancy and causes of death. The spinal cord injury the model. Georgia Regional Spinal Cord Injury Care System, Washington DC 1989 pp66-71.
25. Harrington T, Barker BN. Multiple trauma associated with vertebral injury. *Surg Neurol* 1986; **26**: 149-154.
26. Tindall S, Bierbrauer K. Brain and spinal injuries caused by missiles. In Long D ed *Current Therapy in Neurological Surgery* Philadelphia BC Decker Inc 1989 ed 2 pp 187-190.
27. Venger BH, Simpson RK, Narayan RK. Neurosurgical intervention in penetrating spinal trauma associated with visceral injuries. *J Neurosurg* 1989; **70**: 514-518.
28. Waters RL, Adkins RH. The effects of removal of bullet fragments retained in the spinal canal: A collaborative study by the National Spinal Cord Injury Model System. *Spine* 1991; **16**: 934-939.
29. Benzel EC, Hadden TA, Coleman JE. Civilian gunshot wounds to the spinal cord and cauda equina. *Neurosurgery* 1987; **20**: 281-285
30. Kao CC, Chang LW. The mechanism of spinal cord cavitation following spinal cord and cauda equina. *Neurosurgery* 1987; **20**: 281-285.
31. Isiklar ZU, Lindsey RW. Gun shot wounds to the spine. *Injury* 1998; **29**(suppl 1): SA7-SA12.
32. Clark RA. Analysis of wounds involving the lumbosacral canal in the Korean War. In Meierowsky A Ed. *Neurological Surgery of Trauma*. Washington DC Office of the Surgeon General 1965: 337-344.
33. DeMuth WE. Bullet velocity and design determinants of wounding capability. *J Trauma* 1966; **6**: 222-232.
34. DeMuth WE. Bullet velocity as applied to the military rifle wounding capacity. *J Trauma* 1969; **9**(1): 27-38.
35. Wang D-W, Wang Z-S, Yin X-G, et al. Histologic and ultrastructural changes of the spinal cord after high velocity missile injury to the back. *J Trauma* 1996; **40**(3): S90-S93.
36. Ohry A, Rozin R. Spinal cord injuries in the Lebanon War. *Isr J Med Sci* 1984; **20**: 345-349.
37. Rautio J, Paavolainen P. Afghan war wounded: Experience with 200 cases. *J Trauma* 1988; **28**: 523-525.
38. Simpson RK, Venger BH, Fischer DK, Narayan RK, Mattox KL. Shotgun injuries of the spine: Neurosurgical management of five cases. *Br J Neurosurg* 1988; **2**: 321-326.
39. Kihitir T, Ivatury RR, Simon R, Stahl WM. Management of transperitoneal gunshot wounds to the spine. *J Trauma* 1991; **31**: 1579-1583.
40. Zipnick RI, Scalca TM, Troskin SZ, et al. Hemodynamic responses to penetrating spinal cord trauma. *J Trauma* 1993, **35**(4): 578-582.
41. Six E, Alexander E, Kelly D, Davis CH, McWorter JM. Gunshot wounds to the spinal cord. *South Med J* 1979; **72**: 699-702.
42. Bracken MB, Shepard MJ, Holford TR, et al. Administration of methylprednisolone for 24 or 48 hours or tirilazad mesylate for 48 hours in the treatment of acute spinal cord injury. Results of the Third National Acute Spinal Cord Injury Randomized Controlled Trial. National acute spinal cord injury study. *JAMA* 1997; **277**(20): 1597-1604.

43. Levy ML, Gans W, Wijesinghe HS, *et al.* Use of methylprednisolone as an adjunct in the management of patients with penetrating spinal cord injury: Outcome analysis *Neurosurgery* 1996; **39(6)**: 1141-1149.
44. Braughler JM, Hall ED, Means ED, *et al.* Evaluation of an intensive methylprednisolone sodium succinate dosing regimen in experimental spinal cord injury. *J Neurosurg* 1987; **67**: 102-105.
45. Heary RF, Vaccaro AR, Mesa JJ, *et al.* Steroids and gunshot wounds to the spine. *Neurosurgery* 1997; **41(3)**: 576-583.
46. Prendergast MR, Saxe JM, Ledgerwood AM, Lucas CE, Lucas Wf. Massive steroids do not reduce the zone of injury after penetrating spinal cord injury. *J Trauma* 1994; **37(4)**: 576-579.
47. Teitelbaum GP, Yee CA, vanHorn DD, Kim HS, Colletti PM. Metallic ballistic fragments: MR imaging safety and artifacts. *Radiology* 1990; **175(3)**: 855-859.
48. Heiden JS, Wiess MH, Rosenberg AW, Kurze T, Apuzzo MLJ. Penetrating gunshot wounds of the cervical spine: Review of 38 cases. *J Neurosurg* 1975; **42**: 575-579.
49. Stauffer E, Wood R, Kelly E. Gunshot wounds of the spine: The effects of laminectomy. *JBJS* 1979; **61A**: 389-392.
50. Barkana Y, Stein M, Scope A, *et al.* Prehospital stabilisation of the cervical spine for penetrating injuries of the neck - is it necessary? *Injury* 2000; **31**: 305-309.
51. Matson DD. The treatment of acute compound injuries in forward army hospital. *J Neurosurg* 1946; **3**: 114-119.
52. Davidoff LM. Spinal cord injuries. *Surg Clinics of North America* 1946; **21**: 433-441.
53. Yashon D, Jane JA, White RJ. Prognosis and management of spinal cord and cauda equina bullet injuries in sixty five civilians. *J Neurosurg* 1970; **32**: 163-170.
54. Robertson DP, Simpson RK. Penetrating injuries restricted to the cauda equina: A retrospective review. *Neurosurgery* 1992; **31**: 265-269.
55. Kupcha PC, An HS, Cotler JM. Gunshot wounds to the cervical spine. *Spine* 1990; **15(10)**: 1058-1063.
56. Kaufman HH, Pait TG. Gunshot wounds to the spine. *Contemp Neurosurg* 1993; **15**: 1-6.
57. Villandre G, Morgan JD. Movement of foreign bodies in the brain. *Radio Electroh* 1961; **21**: 22-27.
58. Arasil E, Tascioglu AO. Spontaneous migration of an intracranial bullet to the cervical spinal canal causing Lhermitte's sign. *J Neurosurg* 1982; **56**: 158-159.
59. Kerin DS, Fox R, Mehringer CM, *et al.* Spontaneous migration of bullet in the central nervous system. *Surg Neurol* 1983; **20(4)**: 301-304.
60. Tanguy A, Chabannes J, Deubelle A, Vanneville G, Delens B. Intraspinial migration of a bullet with subsequent meningitis - a case report. *JBJS* 1982; **64A**: 1244-1245.
61. Karim NO, Nabors MW, Golocovsky M, Cooney FD. Spontaneous migration of a bullet in the spinal subarachnoid space causing delayed radicular symptoms. *Neurosurgery* 1986; **18(1)**: 97-100.
62. Soges LJ, Kinnebrew GH, Limaco OG. Mobile intrathecal bullet causing delayed radicular symptoms. *AJNR* 1988; **9**: 610.
63. Gupta S, Senger RLS. Wandering intraspinal bullet. *Br J Neurosurg* 1999; **13(6)**: 606-607.
64. Bowen TE, Bellamy RF. Emergency war surgery. Second US revision of the *Emergency War Surgery NATO Handbook*. Washington DC, US Government Printing Office, 1988.
65. Velmahos GC, Degiannis E, Hart K, Souter I, Saadia R. Changing profiles in spinal cord injuries and risk factor influencing recovery after penetrating injuries. *J Trauma* 1995; **38(3)**: 334-337.
66. Velmahos G, Demetriades D. Gunshot wounds of the spine: Should retained bullets be removed to prevent infection? *Ann R Coll Surg Engl* 1994; **76**: 87-87.
67. Lin SS, Vaccaro AR, Reisch S, Devine M, Cotler JM. Low velocity gunshot wounds to the spine with an associated transperitoneal injury. *J Spinal Disord* 1995; **8**: 136-144.
68. Roffi RP, Waters RL, Adkins RH. Gunshot wounds to the spine associated with a perforated viscus. *Spine* 1989; **12**: 808-811.
69. Romanick PC, Smith TK, Kopaniky DR, Oldfield D. Infection about the spine associated with low velocity missile injury to the abdomen. *JBJS* 1985; **67A**: 1195-1201.
70. Grogan DP, Bucholz RW. Acute lead intoxication from a bullet in an intervertebral disc space. *JBJS* 1981; **63A(7)**: 1180-1182.
71. Conway JE, Croffard TW, Terry AF, Protzman RR. Cauda equina syndrome occurring nine years after a gunshot injury to the spine. *JBJS* 1993; **75A(5)**: 760-763.
72. Wu WQ. Delayed effects from retained foreign bodies in the spine and spinal cord. *Surg Neurol* 1986; **25**: 214-218.
73. Shroyer RN, Fortson CH, Theodotou CB. Delayed neurological sequelae of a retained foreign body (lead bullet) in the intervertebral disc space. *JBJS* 1960; **42A**: 595-599.
74. Jones RE, Bucholz RW, Schaefer SD, *et al.* Cervical osteomyelitis complicating transpharyngeal gunshot wounds to the neck. *J Trauma* 1979; **19**: 630-634.
75. Samsa GP, Parick CH, RFeussner JR. Long term survival of veterans with traumatic spinal cord injury. *Arch neurol* 1993; **50**: 909-914.
76. McKinley WO, Johns JS, Musgrove JJ. Clinical presentations, medical complications and functional outcomes of individuals with gunshot wound induced spinal cord injury. *Am J Phys Med Rehabil* 1999; **78(2)**: 102-107.