



Clinical Case Series

Treatment of severe double spinal cord injuries

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This is a case report describing an injury – sustained by a 25-year-old man during a car accident, and characterized by fracture dislocation of the spine at the level of C7 and T4 accompanied by pulmonary contusion. He had an incomplete spinal cord lesion at the level of C7 and a complete lesion at the level of T4 (T4 ASIA A). Imaging of the spine showed three column fractures with ventral spinal cord compression at both levels. Discussants of this case comment on the concept of acute treatment of severe double spinal cord injuries, and present their chosen way of management in this particular case.

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Case presentation

A 25-year-old male was admitted after a car accident. He suffered severe low cervical and upper thoracic spine injuries. On admission the neurologic examination revealed complete motor function loss from the level of C7, incomplete sensory loss from C7 to T3, and complete loss of both motor and sensory functions from the level of T4 with overflow incontinence (Frankel B from C7 to T3, and Frankel A from T4, ASIA motor score 10, sensory score 52). Megadose methylprednisolone treatment was administered according to NASCIS 3, starting 1 h after injury. X-ray, CT scan and MRI showed three column fractures both in the levels of C7 and T4 with ventral encroachment and severe medullary compression at both levels. The most informative MRI pictures revealed contusion and traumatic oedema of the spinal cord at both of the injured levels (Figure 1). The chest X-ray showed mild pulmonary contusion. He had no other injuries. His primary laboratory parameters were normal.

Questions to the discussants concerning treatment of this case

1. Do you advise conservative or operative treatment?

2. Which level would you treat conservatively, and which operatively?
3. If any or both are to be treated by surgery what is the timing of the surgery, which level should be operated on first, and what should be the time interval between the operations?
4. If surgery is advocated, what are the details of the operations at both levels?
5. If conservative treatment is advocated, what are its most important measures?
6. What is the indication for the chosen treatment in this particular case?
7. What is the expected neurological prognosis in this case?

Five different opinions on management of the patient are presented from various parts of the world.

First opinion

CH Tator, MD, PhD, FRCSC, Toronto, Canada

This patient likely requires surgical decompression of the burst fracture at C7, which is continuing to compress the spinal cord. The injury to the spinal cord at C7 is an incomplete injury because the patient has preserved sensation from C7 to T3. Therefore, there is a possibility that there would be some recovery following decompression. In my opinion the best opportunity for recovery occurs in patients in whom the spinal cord has been adequately decompressed. I

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Figure 1 (a) T1 and (b) T2. MRI images on admission: fracture dislocations of C7 and T4 with multiple fragmented fractures of the bodies, disc lesion above and below the vertebrae, and ventral encroachment of the spinal canal with severe spinal cord compression and oedema at both levels

would be in favour of doing this operation early rather than late, and in this case I would probably want to do the operation within the first 3 days or so, assuming that there is no clinical deterioration. I am quite sure that the axial views would confirm the need for surgery by providing additional evidence of compression of the spinal cord.

I would recommend an anterior approach including a corpectomy of C7 with complete removal of the C6–C7 and C7–T1 discs followed by autologous iliac

crest bone graft and instrumentation with plate and screws extending from C6 to T1.

In my view, the treatment of the T4 compression fracture is quite controversial. I am sure that there will be advocates for both conservative and operative treatment. In my view, there is no definite proof that operation would produce any neurological improvement. Also, I do not feel that it is absolutely essential to perform surgery to achieve stability in this case. It is quite likely that a thoracic shell brace worn for 3 months would prevent further kyphotic deformity from occurring.

Second opinion

TEP Barros, M.D., Ph.D., Sao Paulo, Brasil

The occurrence of concomitant noncontiguous spine fractures is not uncommon, being described as 3.2% by Griffith,¹ 4.2% by Kewalramani and Taylor,² 4.5% by Calenoff *et al*³ and 16.7% by Tearse *et al*.⁴ This particular case is important in re-emphasising the principle that patients with injury at more than one level of the spine should have radiographic examination of their entire vertebral column, including the sacrum.⁵

The case presented to be discussed refers to a young patient with C-7 and T-4 fractures, with a neurologically incomplete injury (Frankel B) from C-7 to T-3 and complete (Frankel A) below T-4. In this clinical situation, since the patient does not have any other injuries, I would recommend surgical treatment as soon as the period of spinal shock is over and the clinical situation of the patient was stable. I would perform the surgical procedure at both levels at the same time, with posterior instrumentation employing titanium material, in order to permit posterior MRI evaluation. At first, I would perform the cervical stabilisation.

After the posterior stabilisation it would be important to have a control MRI image specially at the C-7 level, to evaluate whether there is any residual anterior compression. If a significant residual anterior compression at the C-7 level is found, an anterior decompression could be performed, associated with tricortical iliac graft and plate stabilisation from C-6 to T1.

In the upper fracture partial or even total neurological recovery could be expected, since it is an incomplete neurologic lesion, but unfortunately for the lower fracture the usual neurological prognosis is bad, no return of motor and sensory function being expected, as it is a Frankel A injury.

Third opinion

WS El Masry, M.D., Ph.D., FRCS Ed, Oswestry, England

This unfortunate 25-year-old man sustained a double injury of the spine at C7 and T4 following a

road traffic accident. Both injuries were in compression resulting in burst fractures of C7 and T4 with spinal canal encroachment and minimal to moderate impingement of the spinal cord at both levels. Neurologically the patient seems to have presented with complete cervical spinal cord lesion below C7 with a zone of partial preservation between C7 and T3. Unfortunately it is not clear how long after the accident this neurological examination was documented. The compressive force that has been exerted to cause these two fractures must have been significant and it is very possible that the car rolled over in the process. It is difficult to comment with any certainty about the relative magnitude of force impacted on the spinal cord at the level of C7 as compared to the level of T4. From both the clinical and radiological presentations, in my opinion, it is the fracture of C7 that resulted in the major neurological impairment in spite of the presence of cord oedema at both injured levels.

Assuming the patient is of sound mind and appears to be cooperative and reliable I will offer this patient the choice between surgery (decompression ± stabilisation) and conservative management. I will explain in some detail the techniques, advantages and disadvantages of both methods as well as the possible outcome and related potential complications. If the patient requests my advice about a preference, or empowers me to make the final decision on his behalf, my preferred treatment of both the cervical and thoracic injuries would be conservative. I will explain to the patient however that if during the course of close neurological monitoring he exhibits any signs of neurological deterioration, a repeat MRI will be required, and if further cord compression is detected he is likely to require surgery. Following the insertion of skull calipers and traction with 6 lbs weight, I would treat this patient in recumbency for a period of 6 weeks. During this period I will also manage his multisystem dysfunction and psychosocial disruption, trying to prevent most medical and non-medical complications. Following this period, having excluded a fracture of the sternum and/or ribs, I will mobilise this patient in a firm cervical collar. If a sternal or rib fractures are present and not adequately healed I may also supply a Jewett brace. The spinal support need not be applied for more than 6 weeks, at the end of which, dynamic views of cervical and thoracic spine will be taken. During this period the patient would be undergoing incremental physical, psychological and social rehabilitation. At about 12 weeks following injury the spinal support will be discarded and the patient will carry on an intensive rehabilitation programme in order to gain maximum independence in activities of daily living, personal care and hygiene.

The patient will probably be discharged to his home at about 4–5 months from injury. The liaison with the community would have commenced in the first week of admission to the Spinal Injuries Centre. Provided

this patient does not develop hypoxia, hypotension, pressure sores, severe urinary infections or septicaemia, I would expect him to recover significantly both motor power and sensation in the zone of partial preservation between C7 and T4. His chances of recovering significant motor power and sensation below the level of T4 would be in region of 5% to 10%. If, on the other hand, sacral sparing of pin prick sensation was present at 72 h from injury, his chances of significant recovery to ambulation with expert conservative management would be in the region of 25% to 30%.

If this patient chooses surgery, or has an associated head injury, or is uncooperative or develops behavioural problems I would strongly consider surgical decompression and fusion of C7 through an anterior approach followed by anterior surgical stabilisation with a plate. The main reason I would prefer conservative management are the following: Since the statements by Guttman and Frankel it has been demonstrated again and again that the maximum damage to the spinal cord occurs at the time of the accident. This was recently reiterated by Limb *et al*⁶ in 1995. My own work together with my colleagues in Oswestry in 1993⁷ and 1996⁸ strongly suggests that with expert conservative management significant neurological recovery occurs in almost all patients with incomplete cord injuries. Boerger *et al* in July 2000⁹ reviewed the literature and came to a similar conclusion stating that clearance of the spinal canal is not necessary for neurological recovery. Unfortunately, I cannot find any convincing evidence in the literature to suggest that either the speed of recovery or the final neurological outcome are improved by surgery (decompression ± stabilisation) in patients with complete or incomplete cord injuries. Nor can I find any evidence to suggest that the total hospitalisation time from injury to discharge home of a fully rehabilitated patient is any shorter with surgery. Furthermore, there is no information in the literature about the post discharge rehospitalisation that may be required because of complications from surgery or surgeon's preference to remove the implant.

Considering that both the C7 and the T4 fractures of this patient are likely to heal very well with conservative management, considering there are no proven advantages from surgery (decompression, stabilisation or both) and considering that there is a potential risk to the physiologically unstable injured cord¹⁰ from surgery and/or the parasurgical procedures which could result in neurological deterioration, it is in the best interest of this patient to be treated conservatively if he is capable and willing to cooperate. The quality of management of the multisystem dysfunction in this patient is at least as relevant to the neurological outcome and outcome in general, as is the management of the spinal injury. Appropriate resource distribution is therefore paramount in order to achieve maximum benefit to the patient and the health care service.

Fourth opinion

PS Ramani, M.D., FRCS, FNAMS, D.Sc. Mumbai, India

1. Conservative or operative treatment?
Operative treatment.
2. Which level for conservative treatment and which level by operative treatment?
Immediately C7 level by operative treatment and observe. Later on if the patient gets pain which interferes with rehabilitation then stabilisation, along with decompression at T4 level as well.
3. If any or both are treated by surgery what is the timing, which should be done first, and at one or two different sittings?
Surgery at C7 immediately. Surgery to be withheld at T4 and performed if pain at the dorsal T4 level interferes with rehabilitation. The second operation, if it needs to be done, may be performed 6 weeks after injury.
4. If surgery, what are the details of operations at both levels?
At the C7 level, an anterior decompression and titanium implant and then posterior stabilisation with Hartshill ring and bone grafts. The posterior technique can be changed to the Magerl technique.
The T4 fracture may only need anterior transsternal decompression and titanium cage stabilisation. In view of rib cage support he may not need posterior support although all the three columns are involved.
5. There is no place for conservative treatment.
6. Indication for treatment:
Cervical operation: decompression and stabilisation, which will help early rehabilitation. There will be improvement in sensation, in view of there being a Frankel B lesion. The second operation is to stabilise the spine to relieve pain. There is no documented evidence that following total loss of sensation useful sensation returns after surgery, which can be utilised clinically to the benefit of the patient.
7. What is the prognosis?
The patient will remain tetraplegic, but in view of the injury being at C7 upper limb strengthening can be used clinically to the patient's advantage.

Fifth opinion

A Csókay, M.D. and T Pentélenyi, M.D. Ph.D., Budapest, Hungary

1. Conservative or operative treatment?
Both of the fractures mentioned above are three column unstable fractures. Because of the neurological lesions and spinal instability early surgical procedures are recommended at both levels. The fact that the MRI revealed no severe structural

lesion in the spinal cord is an extremely important sign that urgent operation is indicated to avoid sustained compression and diminish the secondary lesion of the neural elements.

2. Which level would be treated conservatively, and which operatively?
Regarding the significant ventral compression of the spinal cord at both levels, immediate operations are advised to achieve early decompression, reduction and stabilisation at both C7 and T4 levels.
3. If any or both are treated by surgery, what is the timing, which should be done first, and what should be the time interval?
The first operation must be on the cervical spine, and the second operation on the thoracic spine, both in the first 8–12 h. The cervical spinal cord lesion is incomplete, with a much higher chance of neurology recovery. The statistical probability of neurological improvement in the clinically complete spinal cord lesion at the T4 level is much less, but not excluded since there is the chance of the presence of spinal shock completing the clinical picture of a partial neurological lesion.

4. If surgery, what are the details of operations in both levels?

In this case ventral compression was dominant at both affected levels, and in our opinion urgent decompression is reasonable. For the cervical fracture ventral decompression, removal of the torn disc and broken vertebral body, reduction, cortico-cancellous bone grafting and ventral titanium plate fixation are to be performed. For the thoracic fracture ventral and posterior exposures are equally feasible, but in the present case anterior surgery seems to be a better choice regarding decompression and stabilisation.

Right upper thoracotomy, resection of the T4 vertebral body and discs above and below, complete ventral decompression, cortico-cancellous bone grafting and titanium Z plate stabilisation are to be done.

5. If conservative treatment, what are its most important measures?
We would not treat such injuries conservatively.
6. What is the indication for the chosen treatment in this particular case?

Incomplete spinal cord lesion at the C7 level with ventral compression and instability. Clinically complete spinal cord lesion in T4 level with fracture dislocation and ventral compression. The MRI did not reveal complete transection of the spinal cord. The ventral compression and oedema are significant. Early operation is indicated to avoid or diminish secondary injury. Surgical stabilisation promotes early rehabilitation.

7. What is the expected neurological prognosis in this case?

Motor function improvement to the level of useful movement in about 60%, and sensory function improvement to mild hypaesthesia in about 70% in



Figure 2 Postoperative CT sagittal reconstruction: The spinal canal is free of ventral encroachment now, with a corrected sagittal contour



Figure 3 Postoperative X-ray, a–p view. Ventral Orion and Z plates are visible, spine is stabilised in good position

the C7–T3 levels. Motor function improvement to the level of useful movements in about 10%, sensory function improvement to medium hypaesthesia in about 20%, and no voluntary sphincter function, as consequent of the lesion down from T4.

What was done?

Double operations were performed as emergency surgery in the first 12 h. Firstly, the cervical operation was achieved by a ventral approach. Resection of the C7 vertebral body and disc removal, decompression, reduction, cortico-cancellous bone grafting and C6–T1 ventral plate fixation was done with a titanium Orion plate and screws (Sofamor-Danek) within 6 h. Subsequently ventral decompression by T4 body resection and disc removals, cortico-cancellous bone grafting and T3–5 ventral titanium Z plate fixation (Sofamor-Danek) were done via a right upper transthoracic approach within 10 h (Figures 2 and 3). On the second postoperative day improving motor function of the arms and slight but progressive improvement of sensory function (nerve root function) were observed. From the seventh postoperative day the patient started to move his legs and during rehabilitation he presented further gradual improvement in spinal cord function. Half a year later he could walk with one stick (Figure 4), and 1 year later he returned to his profession with slight paraparesis. His sphincter and sexual functions also returned completely after 1 year (Frankel D, ASIA motor score 90, sensory score 190).

Discussion

It is striking that there are so many differences and divergencies of opinion among the experts, concerning the treatment of a patient with such a severe spinal injury. At the same time all of the present discussant authors are leading specialists of spinal trauma in different parts of the world, and all of them represent modern, up-to-date standards and wide experience in their specialties. Since all of the co-authors are convinced that their methods are the best, identified by the data of evidence-based medicine their arguments must be respected. In this situation the Case Report plays an important role in understanding and learning from each other's points, and sometimes adopting others' methods. It is interesting that the only question in which all co-authors agreed was the bad prognosis in neurology function, so much so that it is very surprising that in this particular case a good recovery was seen. Of course the unexpected and surprising good neurological result does not mean that the general estimate of recovery was incorrect. This is an exceptionally good outcome which occurs only in about 10 per cent of the clinically complete spinal cord injury cases. The presenting authors are convinced that the good recovery in this severe double spinal cord



Figure 4 The patient can walk with one stick 6 months after injury. At that time his ASIA motor score was 75, sensory score 156. One year after injury his motor score had improved to 90, and his sensory score to 190

contusion case is due first of all to the emergency ventral decompressive surgeries, both in the first 12 h, plus early neuroprotective medication and complex neurorehabilitation.^{11,12,13,14}

Conclusion

Since there are no results of randomised, placebo-controlled, properly grouped clinical studies concerning primary decompressive surgery its value remains controversial or at least statistically non identified. Most spinal surgeons worldwide agree that spinal cord decompression can be beneficial at least to a certain extent, and this procedure must be represented in the

management of severe spinal cord injuries until the well known organisational, technical and ethical difficulties of a proper clinical trial are overcome.

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