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Clinical Case of the Month

Surgical management of incomplete cervical cord injury with stenosis secondary to ossification of the posterior longitudinal ligament

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Introduction

The development of an incomplete spinal cord injury after a minor cervical trauma in patients with pre-existing cervical stenosis and ossification of posterior longitudinal ligament (OPLL) is common. Unless a bony fracture or subluxation is also present, the benefits of treating incomplete spinal cord injury surgically are controversial. Timing of surgical intervention in such cases is more complicated.

I have sought the expert opinion of four senior neurosurgical specialists in the management of cervical OPLL complicated by minor cervical trauma.

Case presentation

YS Kim, MD, PhD; DK Chin, MD, PhD

A 62-year-old male presenting with symptoms of quadriparesis after blunt neck trauma was admitted to the emergency room (ER). Before the injury he had performed normal daily activities without any difficulty. The vital signs were stable. On neurological examination at the ER, the motor power of upper and lower extremities were grade II and grade IV respectively. The last intact level of sensation was C4 and from below this level hypoesthesia and hypoalgesia was noted. The initial X-ray film (lateral view). MRI and post-operative X-ray are presented in Figure 1.

Skeletal traction with graphite tongs was applied in the ER and the cervical spine was stabilized. High-dose methylprednisolone was administered intravenously almost immediately on arrival at the ER. The neurological condition of the patient showed steady improvement during the first 2 weeks but on the third week the improvement came to a halt and plateaued for a week. We decided to decompress the stenotic spinal canal and perform an expansive laminoplasty from C3 to C7.

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Discussion point

(1) When would you perform the surgical intervention in this case?
(2) What kind of surgery would you like to perform?

First opinion

CH Tator, MD, PhD, FRCSC

This patient represents an interesting example of a spinal cord injury without radiological evidence of trauma (SCIWORET).[1,2] SCIWORET is defined as a spinal cord injury in a patient with pre-existing non-traumatic lesions of the spinal column such as cervical spondylosis, spinal stenosis, ankylosing spondylitis, and disc herniation, but in whom the X-rays do not show evidence of trauma. In the present case, the patient has marked spinal stenosis due to ossification of the posterior longitudinal ligament (OPLL). Indeed, the X-rays of this patient indicate that he has both OPLL and diffuse idiopathic skeletal hyperostosis (DISH). The association of DISH with OPLL is as high as 40% to 50% in some series.[3,4]

The spinal cord injury occurred in this case after minor trauma and the neurological deficit consisted of the upper limbs being weaker than the lower limbs which is characteristic of the central cord syndrome. Currently, this syndrome is considered to be due to injury to the corticospinal tracts, which are now known to play the major role of innervating the distal limb musculature, especially of the upper

a

b

c

Figure 1 Radiographs of the patient with cervical OPLL which was complicated by trauma. (A) Pre-operative cervical spine lateral X-ray demonstrates continuous type OPLL and OALL. (B) Pre-operative cervical MRI shows severe cervical canal stenosis and high signal change in spinal cord. (C) Post-operative cervical spine lateral X-ray shows cervical expansive laminoplasty

limbs.[5–7] In contrast, the original anatomical and pathological explanations for this syndrome given by Schneider *et al*. implicated central hemorrhagic necrosis and damage to only the medial portion of the corticospinal tracts, which were thought to innervate the hands.[8]

(1) Timing of surgical intervention

Schneider originally argued against early surgical treatment for this condition, but he later modified this position especially in the presence of a significant space occupying lesion due to disc.[9,10]

Unfortunately, there is still a great deal of uncertainty about the indications and timing of surgical intervention in patients with the central cord syndrome. It is my view that when there is a significant space occupying lesion in the spinal canal, surgical decompression is indicated, although most patients will still have a significant neurological deficit post-operatively especially in the small muscles of the upper extremities. With respect to the timing of surgical intervention, there is also great uncertainty. The subject of the timing of surgical intervention in acute spinal cord injury was recently reviewed in our publications from the Surgical Treatment of Acute Spinal Cord Injury Study (STASCIS) group of surgical investigators.[11–13] Unfortunately, there has only been one randomized prospective control trial of the timing of surgical decompression in patients with acute spinal cord injury. Vaccaro *et al*. showed that there was no difference in outcome between patients operated on early as compared with late decompression. However, it should be noted that the mean time from injury to decompression was 1.8 days in their early group compared with 16.8 days in the late decompression group.[14] In the present case, my preference would have been to perform surgery as soon as possible after admission, preferably within 8 h.

(2) Method of surgical treatment

In patients requiring decompression over several spinal segments, the advantages of anterior decompression include the ability to achieve a more thorough and complete decompression of the spinal cord. But the disadvantages are higher complication rates of surgery and also more difficulty in graft placement and in the achievement of a solid fusion generally requiring homologous bone grafts.

In the past, the disadvantages of posterior decompresssion included progressive deformity and instability of the spinal column, and possibly less recovery of neurological function due to a less complete and thorough decompression of the spinal cord. However, currently any evidence of instability detected preoperatively or at the time surgery can be treated with lateral mass screws and plates and autologous bone graft.

In the presence of a large anteriorly located space occupying lesion, my recommendation is to perform an anterior decompression. However, in this case the compression of the spinal cord is very extensive and involves from C2–3 to C6–7, and would have required a corpectomy of C3, C4, C5 and C6, which is a very extensive procedure to perform in a 62-year-old person. Even though the T2 signal changes in the spinal cord were confined to C4–5, the CT scan and MRI indicate that the compression extended over more levels than the T2 signal changes. Therefore, I would have performed a posterior decompresssion, which would have involved a laminectomy of C3, C4, C5 and C6. I may also have removed a small portion of the lamina of C2, if at surgery it appeared to be indenting the dural sac, and the same at C7 if required. Any evidence of instability of the spinal column detected preoperatively or at operation, would have been treated with lateral mass screws and plates augmented by autologous bone graft. In my view, there is no proof that an expansive laminoplasty is better than laminectomy, and there are several papers which indicate a lively controversy about this issue.[15–17]

Second opinion

H Nakagawa, MD, PhD

This is a case of incomplete cervical cord injury in a 62-year-old man with canal stenosis due to mixed type OPLL in addition to OALL (ossification of the anterior longitudinal ligament) at multiple levels. Cervical X-ray films do not show a fracture or dislocation but magnetic resonance (MR) images disclosed cord compression from C2 to C5 with a high signal intensity lesion at C4/5. One question is whether instability at C4/5 or any other level is present or not, since no dynamic X-ray study was carried out in this patient.

As the patient steadily improved for 2 weeks after incomplete cervical injury with appropriate treatment by neck stabilization and high-dose methylprednisolone therapy, there is no sense rushing into surgery at this point.

However, when quadriparesis stopped improving and neuroimaging clearly demonstrated significant cord compression from C2 to C5, we would prefer to go ahead with a decompressive posterior approach, that is expansive laminoplasty.

If a dynamic X-ray study revealed any instability and/or operative findings confirmed the presence of instability, I would like to add lateral mass fixation using screws and plate which is easily performed. Regarding expansive laminoplasty, we also often add removal of the lower half of the C2 lamina when there is a tight canal at C2/3 as shown in this case.

If this patient has had difficulty in swallowing due to OALL in addition to myelopathy caused by OPLL and injury, an anterior approach with removal of OALL and corpectomy with removal of OPLL and anterior fusion using iliac graft and anterior plating

could be another way of treating this patient, although this is more complex and demanding in surgical technique.

Third opinion

TJ Pentelenyi, MD, PhD

In the plain X-ray pictures one can see very severe spondylotic deformities which reach the grade of the Forestier syndrome. The whole cervical spine is stiff, and there is very massive OPLL formation. Because of the extreme spondylosis and very well accentuated sclerotisation in the cortical part of the vertebral bodies there is the probability of diffuse idiopathic skeletal hyperostosis (DISH) too.

In the CT and MR a very narrow spinal canal can be identified, and the ventral liquor-space has disappeared. At the C4–5 level marked intramedullary edema is visible secondary to spinal cord contusion. The degree of medullary compression seems to be most severe in this part of the spinal canal. There is significant ossification also in the ligamentum flavum.

There is no traumatic bony lesion. The craniocervical junction shows normal configuration.

In summary: Severe incomplete traumatic spinal cord lesion at the C5 level in a completely stiff and narrow spine with OPLL and severe degenerative alterations. Contusion and compression of the spinal cord.

How should the patient be treated?

Megadose Methylprednisolone administration for 24 h. Since there is an incomplete but severe neurological lesion and acute spinal cord compression in an originally narrow spinal canal, this is an absolute indication for emergency surgery. If the patient's general state is stable and there are no vital contraindications, urgent decompressive surgery must be performed in the first 24 h, possibly during the first 8–12 h. If there is a serious contraindication or any other technical or organizational difficulty, surgery has to be postponed until the necessary conditions have been fulfilled.

Surgery via a ventral approach is advised since space occupation is caused mainly by the ventral structures, and the ventral neural pathways in the cord are more vulnerable than the dorsal ones. Also the neurological picture shows mainly a ventral neural element lesion in this case. During surgery removal of the osteophytes, discs and OPLL in the C3–4 and C4–5 levels, complete decompression of the neural elements, cortico-cancellous bone grafting and ventral titanium plate fixation have to be achieved.

In the postoperative period, an early rehabilitation program and thrombosis prophylaxis are absolutely necessary. Posterior decompressive laminectomy or laminoplasty will probably not be necessary in this case unless clinical and image follow up reveal later progressive space occupation with posterior dominating stenosis.

Fourth opinion

HC Park, MD, PhD

This case represents an incomplete spinal cord injury with central cord syndrome after minor cervical trauma. MR T2 images show cervical canal stenosis between C2–3 and C5–6 with OPLL. The most severely stenotic area is C4–5 and the adjacent cord has high signal change, which suggests cord contusion at this level.

In cervical stenosis, most of the traumatic central cord syndrome is produced by an extension injury. The benefits of emergency decompression in central cord syndrome are controversial. In my view, the treatment of choice is conservative management with skeletal traction and mega-dose methylpredisolone therapy, as was done in this patient. The patient's neurological condition initially improved and then ceased. At that time, one would be faced with two considerations. Firstly, is surgical decompression at the stenotic levels required and could it possibly maximise the neurological improvement? Even though many authors may not agree with the benefits of delayed surgical decompression in central cord syndrome, I have seen further progressive improvement of the neurological deficit in many of my patients. Secondly, how could further spinal cord injury be prevented in severely stenotic patients as in this case? The patient has received only a minor trauma but the outcome is a serious neurological deficit. Regardless of whether the current neurological deficit would be improved or not, the patient is exposed to more chances of injury in his lifetime. With these considerations, I believe decompression surgery to be truly necessary in this case.

There are two ways of surgical decompression, anterior and posterior. As OPLL is located anterior to the cord, anterior removal of OPLL is the best way of surgical intervention theoretically. However, with severe cervical canal stenosis as in this case, a direct anterior approach is very dangerous and may produce further cord damage. Sometimes OPLL adheres to the dura and separation from the dura is not an easy task. In this situation, I prefer a two-staged operation. At first, posterior decompression is carried out followed by anterior removal of OPLL. In this case, the CSF space can be seen above the lowest margin of the C2 body and below the upper one-third of the C5 body, so that decompressive laminectomy or laminoplasty between the lower half of the C2 lamina and the C5 lamina seems to be enough. This posterior decompression could offer more room for cord movement, but more root stretching could be produced. In fact, many of my patients with OPLL who had received posterior decompression had complaints of radicular pains and signs. OPLL is known to progress after laminectomy. So anterior decompression with removal of OPLL is required possibly 7–10 days after posterior decompression when wound healing and stabilisation of the patient's general condition have been attained.

The CT axial scan shows the most prominent OPLL at the C4–5 level and inclined to the right side, but, at C3–4 and C5–6, protruded centrally. MR showed cord contusion at the C4 level only. So in my view, I would perform a corpectomy from the upper one-third of the C5 body to the lower one-third of the C3 body (including a C4 corpectomy). After iliac bone graft, plate and screws fixation, a Philadelphia collar would be applied.

Discussion

YS Kim, MD, PhD; DK Chin, MD, PhD

Ossification of the posterior longitudinal ligament (OPLL) is known to have a high racial prevalence in Asians including Japanese, Koreans and Chinese. It is a chronically progressive disorder of the spine and occurs predominantly in the cervical spine.[18] Most of the symptomatic patients with cervical OPLL present with symptoms and signs of spinal cord compression such as myelopathy or myeloradiculopathy, which is often liable to further devastating deterioration of the neurologic condition even by minor trauma to the cervical spine. The incidence of neurological deterioration after minor trauma was reported as 16% to 28%.[19,20]

During the last 10 years, one of the authors (YS Kim) has operated on 123 patients with cervical OPLL, in which 30 patients (24.4%) were trauma-related. In the clinical manifestation, the central cord syndrome, in which paralysis of the upper extremity is more prominent than that of the lower extremity, is characteristic in trauma-related cervical OPLL patients. The mechanism of injury is thought to be a hyperextension injury of the cervical spine, followed by compression of the spinal cord between the OPLL and ligamentum flavum in the already stenotic spinal canal, which compromises the central gray matter of the spinal cord. The medially placed corticospinal fibers are specifically involved, which results in relatively greater paralysis of the upper extremity than the lower extremity.[5]

There is still considerable controversy about the appropriate timing for surgical decompression in spinal cord injured patients with trauma-related cervical OPLL, as usually the paralysis is incomplete. We have a difference of opinion among our four experts, as two suggested early decompression, and two suggested delayed dcompression.

Cervical OPLL, being a disease predominantly of elderly patients, is usually combined with multiple medical problems and poor general condition. In my series, the mean age of the trauma-related patients was 58.6 years old. The prognosis of central cord syndrome in trauma-related cervical OPLL is known to be favourable with conservative management as some time-related spontaneous neurological recovery is expected. Furthermore, in the acute stage, the possibility for secondary injury from the manipulation of oedematous spinal cord and drug-induced hypotension during surgery should be strongly considered. Therefore in incomplete spinal cord injury associated with trauma-related cervical OPLL, degenerative spondylosis without bony fracture or severe subluxation and intervertebral disc herniation, and if the neurological condition shows steady improvement, surgery should be delayed until the time-related spontaneous neurological recovery plateaus.

There are many different opinions about the appropriate surgical technique in multi-level cervical stenosis, anterior *versus* posterior approach. Each has its merits and limitations.

Among the 123 cases of my series, 73 cases were decompressed posteriorly and the rest anteriorly. In comparing the morphological type of OPLL in relation to the surgical approach, 73% of the anterior approached cases were segmental and other type of OPLL and 84% of the posterior approached cases were continuous and mixed type of OPLL (Figure 2). Also in comparing the length of OPLL in relation to the surgical approach, 89.2% of the anterior approached cases were less than three segments and 76.7% of posterior approached cases were more than four segments (Figure 3).

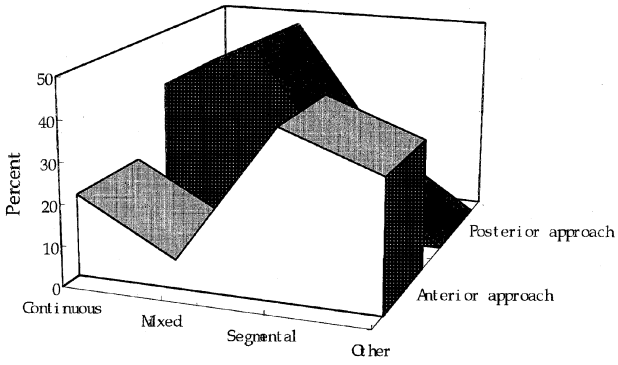

Figure 2 Distribution of OPLL type in relation to the surgical approach, anterior *vs* posterior ($n=123$)

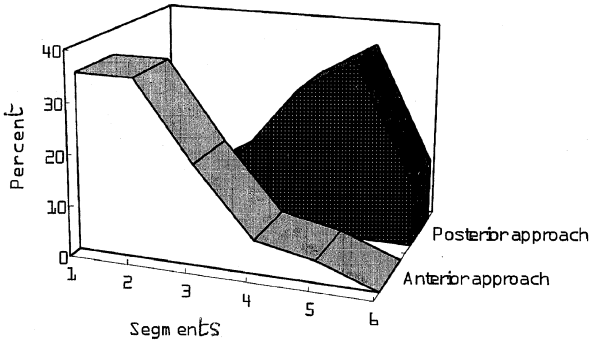

Figure 3 Distribution of the length of OPLL in relation to the surgical approach, anterior *vs* posterior ($n=123$)

Anterior cervical decompression by corpectomy, disectomy and removal of the OPLL is the most direct approach but there may be problems (graft displacement, settling, pseudoarthrosis) especially in long segment fusion of more than three level corpectomy.[21–23] Consequently posterior decompression with expansive laminoplasty is considered a more favourable technique in cases of continuous or mixed type of OPLL and OPLL of more than three levels.[24,25] Therefore, in this case, we decided on the posterior approach of expansive laminoplasty with midline splitting and open door method.

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