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Closed Reduction of Bilateral Locked Facets of the Cervical Spine Under General Anaesthesia

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Summary

Background. Bilateral facet interlocking of the cervical spine is a relatively uncommon type of cervical spinal injury. It is frequently associated with devastating neurological symptoms and signs. Early reduction of the locked facets is thought to be critical in preventing progressive secondary spinal cord injury. Whereas skull tong traction remains our primary option for closed reduction of bilateral locked facets of the cervical spine, it is not always successful, even with heavy traction weights. Other more aggressive measures may occasionally be required. The authors report their experience in reducing bilateral locked facets of the cervical spine by manual closed reduction.

Methods. This small series consists of six cases of cervical spinal injury with bilateral locked facets in which manual closed reduction under general anaethesia and muscle relaxation was used. Three of them presented with complete quadriplegia (Frankel class A). One case presented with incomplete but severe neurological deficits (Frankel class B). After unsuccessful closed reduction with skull traction, these patients were treated by manual closed reduction under general anaesthesia and muscle relaxation, followed by anterior discectomy, interbody fusion and stabilization.

Results. All cases made neurological improvement after the procedures. Even in cases with initial severe neurological deficits, the recovery was remarkable. The recovery was dramatic in two cases. Case 1 improved from Frankel class B to E; and Case 5 from Frankel class A to D. No case deteriorated neurologically after the procedures. Pneumonia occurred in Case 3; and stress ulcer accompanied by haemorrhage was noted in Case 4. None of these complications was directly related to the procedures.

Conclusion. The potential for improvement of neurological function following early and successful reduction and fixation of the dislocated spine is emphasized. With meticulous techniques, manual closed reduction may be an effective alternative to skull tong traction when the latter fails.

Keywords: Cervical spine; locked facets; manual closed reduction; traction.

Introduction

Bilateral facet interlocking is one of the most drastic injuries to the cervical spine. It is usually the result of forceful hyperflexion of the neck. The excessive anterior dislocation of one vertebra on another often causes extensive spinal cord contusion, transection or nerve root avulsion with devastating neurological deficits. Bilateral locked facets of the cervical spine constitute a treatment challenge because measures more aggressive than skull tong traction are frequently required for successful reduction. With regard to the methods of reduction, the timing for sugery, or the modes of stabilization, controversy remains. Few reports have detailed the treatment protocols specifically aimed at bilateral locked facets [14, 22, 26]. However, the consensus that early reduction offers the best chance for neurological recovery and every effort should be made for realigning the dislocated spinal segment is shared by many authors [9, 10, 12, 14, 21–23, 25].

While skull tong traction with progressive increase of weight is currently the most commonly used method for closed reduction of cervical dislocation with or without locked facets, it is not always successful. Manual closed reduction has been advocated by several authors as an effective alternative when skull traction failed [10, 21, 22]. On the other hand, concerns about its safety have been raised [5, 18]. The authors report their experience in 6 cases of bilateral locked facets treated by manual closed reduction under general anaesthesia and muscle relaxation followed by fusion and stabilization.

Methods and Patients

Patient Population and Presentation

Between January, 1995 and November 1997, 15 cases of cervical spine injury with bilateral locked facets were admitted to our institute. In 9 of these cases, successful closed reduction was achieved

Table 1.

Case no.	Age (yr)	Sex	Cause of injury	Level	Traction weight (kg)	Time to MCR
1	42	F	fall	C6–7	27	2 days
2	68	M	fall	C4–5	22	1.5 day
3	46	M	MVA	C5–6	24	22 hours
4	38	F	assault	C6–7	18	2 days
5	57	M	MVA	C5–6	25	18 hours
6	40	M	MVA	C5–6	28	24 hours

MVA Motor vehicle accident; *MCR* manual closed reduction.

with skull tong traction alone. In the other 6 cases, the locked facets were reduced with manual closed reduction under general anaesthesia and muscle relaxation because of failure of skull traction. These 6 patients constitute the small series in this paper.

The clinical characteristics of these patients, including the causes of injury, levels of locked facets, traction weight, and neurological grading according to the Frankel classification before and after treatment are summarized in Tables 1 and 2. All but one case (Case 2) presented with moderate to severe neurological deficits on arrival. Cases 3, 4 and 5 showed complete motor paralysis and sensory anaesthesia below the level of injury (Frankel class A). Case 1 presented with complete motor paralysis and areflexia below the C6 level and partial preservation of sensation (Frankel class B). Case 6 presented with incomplete motor and sensory dysfunction below the C5 level (Frankel class C). Brown-Sequard syndrome was observed in Case 2, who presented with left hemiparesis (muscle power: grade 3/5 in the upper extremity, and grade 4/5 in the lower), and right sensory loss (Frankel class D).

Treatment Protocol

All the 6 patients included in this report were treated according to the following protocol. In our institute, the treatment of cervical spine dislocations starts with meticulous evaluation of haemodynamic and neurological status, simultaneous assessment and treatment of other injuries. Resuscitation is given if necessary. Radiological examinations including plain radiographs and magnetic resonance imaging (MRI) of the cervical spine are performed as soon as the general condition becomes stabilized. Once cervical dislocations with or without locked facets are detected, Cone-Barton skull tongs are applied. The usual initial traction weight is 5 kg for upper and 10 kg for mid- and lower cervical dislocations. The patients are admitted to the intensive care unit for continuous monitoring and serial radiological evaluation. Intravenous steroid administration is routinely given if spinal cord or nerve root injuries are present. The traction weight is increased in 2 to 3-kg increments until reduction is achieved. There is no strict limit of maximal traction weight in our institute. However, if a weight of one third to half of the patient's body weight fails to reduce the dislocation, measures other than traction are usually taken. Decision-making is generally based on the patient's condition and the neurosurgeon's experience and judgement.

Techniques of Manual Closed Reduction

The techniques of manual closed reduction under anaesthesia have been described in detail elsewhere [2, 21]. All the 6 patients were treated by the following procedures.

Once the decision to attempt manual reduction was made, and after the patient's haemodynamic status had been stabilized, the patient was transferred to the operating room. Fiberoscope-guided nasotracheal intubation was done with the patient awake to avoid any extension of the neck. The patient was then given isoflurane and nitrous oxide for general anaesthesia and atracurium for muscle relaxation. Fluoroscopy was used in every case to assess the condition of dislocated vertebrae. Cross-table radiographs are taken if this does not give enough information. A radiographic imaging was obtained first to be sure that the locked facets had not been reduced after anaesthesia. With the patient placed in neutral position and under constant skeletal traction, manual closed reduction was attempted. The neurosurgeon put one hand under the chin and the other behind the occiput of the patient. Traction was applied gently and constantly with slight flexion of the neck. Counter traction was applied to the shoulders by an assistant. During the manipulation, attention was paid to the occurrence of any dull thump or click deep in the patient's neck. This was felt in Cases 1, 2, 5 and 6. A fluoroscopic imaging was obtained immediately after each attempt of manipulation.

Once successful closed reduction was achieved, the traction loads were removed and the patient was carefully moved to the operating table. The cervical spine was approached anteriorly following the Smith-Robinson techniques [17]. An operating microscope was routinely used. The intervertebral disc at the dislocated level was removed. The spinal canal both rostral and distal the disc space was routinely explored for any possible extruded disc fragments. Complete disc excision was followed by interbody fusion with a tricortical bone graft harvested from the iliac crest. Stabilization using the Caspar anterior plate and screws was then performed.

After the operation, cervical collars were used as external orthosis. All the patients received comprehensive rehabilitation programmes.

Table 2.

Case no.	Neurological status (Frankel classification)		Complication	Follow-up periods
	before treatment	at follow-up		
1	incomplete below C6 (Frankel B)	returned to work (Frankel E)	Nil	2.5 years
2	Brown-Sequard syndrome (Frankel D)	completely independent (Frankel E)	Nil	22 months
3	complete below C5, respiratory failure (Frankel A)	quadriparesis below C5, respirator not needed, wheelchair-dependent (Frankel C)	Pnenmonia	19 months
4	complete below C6 (Frankel A)	quadriparesis below C6, wheelchair-dependent (Frankel C)	UGI bleeding	17 months
5	complete below C5 (Frankel A)	ambulatory with a walker (Frankel D)	Nil	11 months
6	incomplete below C5 (Frankel C)	ambulatory without support, mild weakness below C5 (Frankel D)	Nil	3 months

Neurological Outcome and Complications

The time intervals between the injury and manual closed reduction ranged from 18 hours to 2 days. All cases in this series demonstrated neurological improvement after reduction of the locked facets. Even in cases with severe initial neurological deficit (Cases 1, 3, 4 and 5), reduction of the locked facets offered benefits. All cases received programmed rehabilitation later in the same hospital stay.

None of these patients deteriorated neurologically after the procedures. Case 3 suffered from pneumonia postoperatively, though he made progress in his neurological status (Frankel A to C). This case presented with complete quadriplegia and respiratory failure initially. After the procedures, he was weaned from the ventilator successfully as his pneumonia subsided following antibiotic treatment. In case 4, upper gastrointestinal haemorrhage occurred peri-operatively, which was presumed to be caused by stress and the use of corticosteroid. It subsided with conservative treatment.

Illustrative Case (Case 1)

History and examination. A 42-year-old woman was sent to the emergency room of our hospital following a fall. She complained of severe neck pain. Neurological examination disclosed complete motor paralysis below the C6 level. Areflexia of the legs and loss of sphincter tone were noted. Some sensation to pain and pressure were preserved on the trunk and limbs. The initial radiographs revealed C6–7 dislocation with bilateral locked facets (Fig. 1a). MRI showed significant displacement of the dislocated vertebral bodies with spinal cord compression. The intervertebral disc was ruptured anteriorly (Fig. 1b).

She was put in Cone-Barton skull traction for closed reduction of the locked facets. Within the first 2 days, she made some progress in her motor function. There was return of some sphincter tone. The muscle power of the legs improved to grade 1 to 2/5. For successful closed reduction, the traction weight was increased up to 27 kg, which approximated to half of her body weight. The patient's neck pain was aggravated by the traction. This was accompanied by deterioration of the muscle power of her legs. Radiographs showed distraction between the cervical vertebrae, but the C6–7 facet interlocking remained (Fig. 1c). A decision was made to use manual closed reduction under general anaesthesia.

Manual closed reduction and operation. The patient was managed as mentioned above. During manipulation, a dull thump deep in the patient's neck was felt, indicating successful reduction of the locked facets. Manual traction was immediately stopped and the weight on the Cone-Barton tongs removed. A lateral radiograph confirmed reduction of the C6–7 locked facets. Under the same anaesthesia, the patient then underwent removal of the anteriorly ruptured disc, interbody fusion and Caspar plate fixation. Extensive disruption of the anterior and posterior longitudinal ligaments and severe segmental instability were observed intra-operatively. The epidural space was explored and there was no sequestration of any disc fragment.

Postoperative course. The patient's neck pain subsided after the operation. Improvement of limb strength was noted within the first postoperative week. Subsequently she made significant progress regarding motor and sensory functions. She could walk with a walker three months later. Only slight spasticity of gait remained. At 6 months postoperatively, she was freely ambulatory. At the latest follow-up two and a half years after her injury, she had found a job and was completely independent. Follow-up radiographs showed satisfactory bony fusion and cervical spine alignment (Fig. 1d).

Discussion

Bilateral locked facets are caused by hyperflexion of the cervical spine and are usually associated with severe spinal cord injury and neurological deficit [22]. The beneficial influence of early reduction of the locked facets on symptomatic and neurological improvement have been emphasized by many authors [9, 10, 12, 14, 21–23, 25]. It has been a standard practice to attempt closed reduction of bilateral locked facets with skull tong traction. However, restoration of normal spinal alignment is not always possible using this method. The success rate of skull traction in reducing bilateral locked facets reported in the literature ranges from 27 to 90% [9, 14, 20, 22]. The common causes of failure of reduction include deterioration of the neurological deficit, or severe pain and aggravated spasm of the cervical musculature during skull traction, or fracture of the facets at the locked level that precludes successful reduction [23]. When skull traction fails to reduce the locked facets, various management approaches have been advocated. These include application of extra-ordinarily heavy traction weight [3, 11, 20, 26], manual closed reduction under relaxation with or without anaesthesia [10, 21, 22], and open reduction [9, 14].

Manual closed reduction was first described by Walton [24] and subsequently became part of the treatment for dislocations of the cervical spine. Evan [7] reported a series of 17 patients treated by manual closed reduction under general anaesthesia. No patient with an incomplete spinal cord lesion was made worse, and no patient without neurological deficit sustained any during manipulation. Of the 6 patients with initially complete paralysis, 2 made excellent neurological recovery. Burke *et al.* [2] used manupulation under anaesthesia and muscle relaxation to treat 41 patients with bilateral (21 cases) or unilateral (20 cases) locked facets. Failure of reduction was encountered in only 4 patients. Of the 21 cases with bilateral locked facets, 4 showed good to full recovery, and 5 showed slight recovery of their neurological deficit. None of them deteriorated neurologically after manipulation. In

Fig. 1. Case 1. (a) Lateral radiograph showing C6–7 bilateral locked facets. (b) Sagittal T_2-weighted MR imaging showing C6–7 dislocation with compression of the spinal cord. The anteriorly ruptured disc and the signal changes in the spinal cord indicating contusion are also shown. (c) Under 27-kg skull traction, lateral radiograph showed distraction between the C6 and C7 bodies and facets. But the facets remained locked. (d) Follow-up radiograph showing satisfactory spinal alignment and rigid fixation

Sonntag's series of 15 cases of bilateral locked facets, 6 had to be reduced by a combination of traction and manipulation under sedation or general anaesthesia, because traction alone failed [20]. Successful reduction was achieved in these 6 patients without any untoward sequelae.

Despite these successes, the safety of manual closed reduction of cervical spine dislocations under anaesthesia has been questioned [5, 18]. The advantage of this procedure is that anaesthesia and relaxation eliminate the neck pain and muscle spasm which may preclude successful reduction. On the other hand, the disadvantage is inability to monitor the patient's neurological condition as when the patient is awake. Possible overstretching may also cause spinal cord or nerve root injury in the absence of any protecting muscle tone. Mahale *et al.* [13] reviewed 16 patients with cervical dislocations who deteriorated neurologically during or after reduction. Eight of these patients had bilateral, and 5 had unilateral locked facets. One patient had C1–2, and the other 2 had C2–3 dislocation associated with fractures. Skull traction was used in 4 cases, manipulation in 4, operative reduction in 7, and application of cervical collar in the other. It is clear that even skull traction with progressive increments of weight is not without risk and that neurological deterioration during or after reduction can occur with any type of the reduction methods currently used [8, 13]. This fact is supported by the clinical course of Case 1 in our series. According to Mahale *et al.*, attempts at reduction may cause mechanical injury to the spinal cord in an already compromised spinal canal [13]. In Case 1, neurological deterioration occurred during skull traction. In the absence of a posteriorly ruptured disc, the persistent and increasing stretching by the skull traction might cause oedema or vascular compromise, resulting in secondary damage to the spinal cord. In our opinion, when a patient is under general anaesthesia and profound muscle relaxation, less weight is needed for successful reduction than when the patient is awake. The risk of overstetching is actually lowered as long as the manipulation is kept gentle and skillful. Early successful reduction followed by immediate fusion and stabilization also facilitates chest care and allows early active rehabilitation.

Several authors stated that the presence of concomitant disc herniation may be detrimental if closed reduction is attempted [1, 4, 6, 16]. We are of the opinion that MRI of the cervical spine should be obtained whenever possible before reduction is attempted. The presence or absence of a ruptured or a herniated disc and the severity of spinal cord damage at the dislocated level can be best revealed by MRI. All the 6 cases in this series underwent MRI studies of the cervical spine before manual closed reduction was attempted. In none of these cases did MRI show a posteriorly ruptured disc or associated fractures of the facets at the dislocated level, which in our protocol would be taken as a contra-indication to manual closed reduction. The most common finding was spinal cord contusion at the dislocated levels (Cases 1, 3, 4, 5, and 6). In Case 2, who had the mildest neurological deficit, there was no signal change in the spinal cord. In our experience, however, severe disruption of the posterior logitudinal ligaments is almost routinely found intra-operatively. And this may be accompanied by herniation or sequestration of small fragments of a disc into the spinal canal, which may not be well demonstrated by the MRI. We routinely explore the epidural space above and below the disc level with a nerve hook to warrant removal of such sequestered disc fragments. From the postoperative neurological improvement in our cases, two suggestions can be made. First, there remains a potential for functional recovery if MRI shows spinal cord contusion and/or compression rather than transection. Such a finding should prompt the surgeons to take more aggressive measures for reduction than just prolonging skull traction in vain when the locked facets do not yield. Second, minor disc protrusion without significant encroachment on the spinal cord may not constitute an absolute contraindication to manual closed reduction. However, our series is too small to lead to any conclusion in this regard.

To minimize the possible deleterious effects of manual closed reduction under anaesthesia, several precautions are necessary. The presence of hypovolaemic or spinal shock may increase the risk of general anaesthesia. Resuscitation should be done in advance. Respiratory failure after the initial assault is another adverse factor because it increases the risk of postoperative respiratory complications. We routinely perform manipulation in the operating room with the patient intubated and under general anaesthesia and profound muscle relaxation. This virtually eliminates resistance caused by spastic contraction of the neck muscles. We have found fiberoptic nasotracheal intubation with the patient awake advisable because unnecessary neck extension is avoided. We avoid muscle relaxation without intubation and ventilatory support

because paralysis of accessory respiratory muscles in such patients may result in respiratory failure when their pulmorary function has already been compromised by the spinal cord injury [15, 19]. A fluoroscope is routinely used for close monitoring the cervical spine. A radiograph should be obtained before any attempt at reduction, because with full muscle relaxation the locked facets may reduce spontaneously. If manual closed reduction is to be done, it must be gentle. Bursts of forceful traction must be avoided. A dull thump or click deep in the patient's neck felt by the manipulating surgeon most likely indicates successful reduction of the locked facets. However, absence of the thump or click does not necessarily mean that the locked facets have not been reduced (Cases 3 and 4). Each attempt should be followed by intra-operative fluoroscopic or radiographic examination. Once the locked facets are reduced, the traction loads are removed and the neck is kept in neutral position, Following the reduction, we proceed to perform surgery for discectomy, fusion, and fixation under the same anaesthesia. We prefer to use the Smith-Robinson operation for interbody fusion with a tricortical iliac bone graft and Caspar plating for fixation. A posterior approach requires turning of the patient, which may cause redislocation of the extremely unstable spine.

Conclusion

This report provides our preliminary experience with manual closed reduction of bilateral locked facets of the cervical spine with the patients under general anaesthesia and muscle relaxation. Successful closed reduction was achieved in all the 6 treated patients after skull traction was abandoned for various reasons. Improvement of neurological function after reduction was noted in all cases. There was no complication attributable to the procedures. This series is too small for any concrete conclusion. However, the relatively good results seem to imply two ideas. Firstly, there remains a potential for neurological improvement in cases with bilateral locked facets of the cervical spine, as long as the spinal cord is not transected. Early reduction may be of critical importance in terms of preventing permanent secondary spinal cord injuries caused by the mechanical compression of dislocation. Secondly, when skull tong traction fails to reduce the locked facets, manual closed reduction may be a safe and effective alternative, provided it is performed with adequate imaging studies and technical precautions.

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Comments

The authors describe six patients with bilateral locked facets which they were unable to reduce by closed reductions. The patients were then given general anesthesia and reduced. This is a controversial method of treatment; yet, the authors show that in these six cases, they were able to reduce bilateral locked facets successfully. They state that "We believe that muscle relaxation without intubation support and ventilatory support is to be disputed because it may cause respiratory insufficiency or even apnea in patients with cervical spinal cord injury." Have they had this experience?

V. Sonntag

The idea that "muscle relaxation without intubation may cause respiratory failure in patients with spinal cord injury" is based on the knowledge that the pulmonary function of such patients is often impaired and they depend on accessory respiratory muscles for adequate ventilation more than normal individuals do. Paralysis of the accessory respiratory muscles may be detrimental to them. Two references (References 15 and 19) support this.

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