Occasional Review

Elective oral tracheal intubation in cervical spine-injured adults

Valerie S. Suderman MD,* Edward T. Crosby MD FRCPC,* Anne Lui MD FRCPC†

There is controversy regarding the optimal mode of elective tracheal intubation in the patient with an unstable cervical spine following trauma. A ten-year review of 150 patients with traumatic cervical spine injuries with well-preserved neurological function, presenting for operative stabilization, was conducted to compare neurological outcome with the mode of tracheal intubation. Preoperative neurological deficits were identified in 49 patients (33%); most were single-level radiculopathies. Intubation occurred after induction of general anaesthesia in 83 patients (55%) and in 67 patients (45%) the tracheas were intubated with the patient awake. One hundred and six patients (71%) underwent oral tracheal intubation and 44 underwent nasal tracheal intubation. Ten intubations were deemed to be difficult requiring more than one attempt to effect intubation. Cervical spine immobilization during intubation was documented in 86 patients (57%). Weighted traction or manual in-line traction were the two manoeuvres most commonly employed to maintain spinal alignment during intubation. After surgery, two patients had new neurological deficits. There were no differences in neurological outcome whether intubation was peformed while the patient was awake or under general anaesthesia, or comparing oral tracheal intubation with all other techniques (P = 0.5, Fisher exact test). Also, in-line traction did not affect neurological outcome. Oral tracheal intubation with in-line stabilization, either performed after induction of general anaesthesia or with the patient awake, remains an excellent option for elective airway management in patients with cervical spine injuries.

Il existe une controverse concernant le mode optimal d'intubation trachéale élective chez les patients ayant une instabilité cervicale après trauma. Une revue de dix ans de 150 patients présentant un trauma cervical avec la fonction neurologique bien préservée se présentant pour une chirurgie de stabilisation fut conduite afin de comparer l'issue neurologique avec la méthode d'intubation trachéale. Des déficits neurologiques préopératoires furent identifiés chez 49 patients (33%); la majorité étaient des radiculopathies à un seul niveau. L'intubation a suivi l'induction de l'anesthésie générale chez 83 patients (55%) et chez 67% (45%) la trachée fut intubée alors que les patients étaient réveillés. Cent six patients (71%) ont subi une intubation oro-trachéale et 44 ont subi une intubation naso-trachéale. Dix intubations ont été jugées difficiles requérant plusieurs tentatives. L'immobilisation cervicale lors de l'intubation fut documentée chez 86 patients (57%). La traction par des poids ou la traction manuelle furent les deux manoeuvres les plus communément employées afin de maintenir l'alignement cervical lors de l'intubation. Après la chirurgie, deux patients ont présenté de nouveaux déficits neurologiques. Il n'y avait aucune différence dans l'issue neurologique quand l'intubation fut accomplie alors que le patient était réveillé ou sous anesthésie générale, ni en comparant l'intubation oro-trachéale ou les autres techniques (P = 0,5, Fisher exact test). De même la traction manuelle n'a pas affecté l'issue neurologique. L'intubation oro-trachéale avec stabilisation cervicale faite après l'induction de l'anesthésie générale ou chez les patients éveillés demeure une excellente option pour le maintien électif des voies aériennes chez les patients ayant des lésions de la colonne cervicale.

Key words
ANATOMY: cervical spine;
COMPLICATIONS: intubation, trauma;
INTUBATION, TRACHEAL: complications, technique;
SURGERY: orthopaedic, cervical spine.

From the Departments of Anaesthesia, Ottawa General Hospital,* Ottawa Civic Hospital,† University of Ottawa, 501 Smyth Road, Ottawa, Ontario K1H 8L6.

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Address correspondence to: Dr. E.T. Crosby.

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The optimal mode of tracheal intubation in the patient with an unstable cervical spine is controversial. Turner and Joyce criticized the use of both oral tracheal intubation and in-line stabilization for cervical spine immobili-

zation in the spine-injured patient.[1,2] This criticism was based on the observation that spinal movement occurs in both normal and unstable cervical spines during these two manoeuvres and it has been suggested that this movement may result in secondary neurological injury. Meschino cautioned against the use of general anaesthesia and muscle relaxants to facilitate intubation in patients with suspected or proved cervical spinal injury stating that there was no published study to support the safety of this technique.[3] In a literature review, we could not find any study which examined neurological outcome after either intubation or anaesthesia and surgery in this patient population that would provide a basis for such recommendations.[4]

A retrospective study was thus undertaken to review our ten-year experience of adult patients with unstable cervical spines following trauma, who presented for elective operative stabilization. The neurological morbidity after anaesthesia and surgical stabilization was reviewed and the techniques of intubation, either awake or under general anaesthesia, were compared. In addition, the use of traction or in-line stabilization was reviewed in an attempt to determine whether the use of such manoeuvres was associated with increased neurological morbidity.

Methods

The charts of all patients presenting to the University of Ottawa adult teaching hospitals with unstable cervical spines following traumatic injury, who underwent operative stabilization from January 1980 to December 1989, were retrieved. The charts of patients with complete cord injuries, either at or adjacent to the level of spinal injury were excluded from the review because their injury precluded assessment of possible changes in spinal cord function following intubation, anaesthesia and surgery. The sex and age of the patient, the mechanism and level of injury, the preoperative neurological status, and associated injuries were recorded. From the anaesthetic records, the method of intubation, the use and type of spinal immobilization employed during intubation, and the occurrence of technical difficulties during airway instrumentation, were retrieved. The neurosurgical progress notes were reviewed and the postoperative neurological examination was compared with the preoperative state to detect new neurological morbidity. Chi-square analysis or the Fisher exact test were used to test for statistical significance, which was assumed when $P < 0.05$.

Results

The charts of 150 patients with cervical spinal instability presenting for operative stabilization who, before surgery, had either no neurological impairment or a well-defined partial cord injury were reviewed. The patient demographic variables, mechanisms of injury and associated injuries are presented in Table I. Motor vehicle accidents were the main cause of injury. The most common category of associated injuries was orthopaedic, with long bone fractures being the most frequent. The mean age was 37.3 yr (range 14–91 yr). The spinal levels injured are presented in the Figure. Forty-five injuries (30%) occurred at the $C_{1,2}$ level and the remainder (105, 70%) were in the subaxial cervical spine. Forty-nine patients (33%) had neurological deficit before surgery; most were single-level radiculopathies (Table II).

Intubation occurred after induction of anaesthesia and

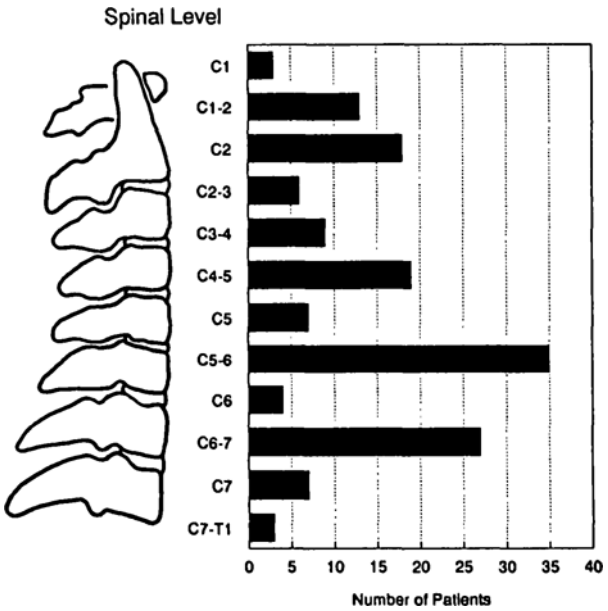

FIGURE *Fracture by spinal level.* The number of patients with fractures at each spinal level is shown.

TABLE I Demographic data

Patient demographics	
Males	112
Females	38
Age yr, mean (range)	37.3 (14–91)
Mechanisms of injury	
MVA	88
Falls	36
Sports-related	27
Blow	1
Associated injuries	
Orthopaedic	18
Abdominal	10
Pulmonary	3

TABLE II Preoperative neurological deficits

Injury	*n*
Radiculopathy – single level	24
Radiculopathy – multiple levels	4
Central cord syndrome	17
Brown-Sequard syndrome	1
Thoracic cord injury	1
Brachial plexus neuropathy	1
Peroneal neuropathy	1

TABLE III Intubation data

Intubation technique	*General anaesthesia*	*Awake*	*Difficult*
Oral intubation			
Laryngoscope	65	20	2
+ Styleted tube	3	2	1
+ Elastic bougie	1	0	1
Lighted stylet	7	8	1
Nasal intubation			
Blind nasal	5	0	1
Fibreoptic bronchoscope	2	37	4
Total	83	67	1

administration of muscle relaxants in 83 patients (55%) and in 67 patients (45%) the tracheas were intubated after topical anaesthesia of the airway, with the patients awake. One hundred and six patients (71%) underwent oral tracheal intubation and nasal intubation was performed in 44 (Table III). Aids to intubation included the fibreoptic bronchoscope (39), a lighted stylet (15), a styleted endotracheal tube (5), and a gum elastic bougie (1). Five patients had blind nasal intubations. Ten intubations (6.6%) were deemed to be difficult, requiring multiple attempts before successful tracheal intubation. In four patients difficult intubation was associated with the use of a fibreoptic bronchoscope and one was associated with the use of a lighted stylet.

The use of spinal immobilization during intubation was documented in 82 patients (55%) (Table IV). The use of weighted traction or manual in-line stabilization were the two manoeuvres most commonly employed to maintain spinal alignment. On four charts, the notation that "care was taken to prevent movement during intubation" was registered but was not explained further. In the remaining 64 patients there was no record to indicate whether or not the neck was immobilized during intubation.

Two patients demonstrated new neurological deficits after surgery. One patient, who was neurologically normal preoperatively, was quadriplegic as a result of a wire being passed accidentally through the cord during the surgical stabilization. One patient awoke with a single level radiculopathy which resolved spontaneously in the 72 hr following surgery. Both these patients had undergone tracheal intubation after induction of anaesthesia and administration of muscle relaxants. The quadriplegic patient had undergone blind nasal intubation which was noted to be easy and the patient with the postoperative radiculopathy had undergone oral tracheal intubation with direct laryngoscopy, which was also without difficulty. A hard collar was left in place during the nasal intubation of the quadriplegic patient, and no notation was made regarding neck stabilization in the second patient.

TABLE IV Techniques of spinal stabilization

Technique	*n*
Weighted traction	34
Manuel-in-line stabilization	27
Halo	13
Philadelphia Collar/Somi brace	8
"Care taken/no movement observed"	4

There were no differences in neurological outcome with intubation awake or under general anaesthesia, with or without the use of spinal immobilization or comparing oral tracheal intubation with other techniques ($P = 0.5$, Fisher's Exact Test).

Discussion

Management of the airway in the adult patient with an unstable cervical spine following trauma is controversial. The two issues that have generated the most controversy have been the optimal mode of tracheal intubation and, more recently, the use of in-line stabilization to immobilize the cervical spine during airway manoeuvres. Avoiding oral tracheal intubation in favour of nasal tracheal intubation or cricothyrotomy in patients with unstable cervical spinal injuries following trauma has been advocated in order to reduce the likelihood of secondary neurological injury during the process of intubation.[1,2] However, no evidence of increased neurological morbidity following elective or emergency oral tracheal intubation in this population has been presented to support this recommendation.

Aprahamian studied cervical spinal movement during airway manoeuvres in a human cadaver with a surgically created unstable cervical spine.[5] He demonstrated that small amounts of spinal movement, both disc space enlargement and subluxation of the injured segments, occurred during all basic and advanced airway manoeuvres. Placement of a nasopharyngeal airway or blind nasal tracheal intubation resulted in somewhat less movement

than other manoeuvres. However, anterior cervical pressure, ostensibly used to stabilize the larynx, resulted in considerably more subluxation at the injured segment during these two manoeuvres. Bivins documented cervical spinal movement during direct laryngoscopic visualization of the vocal cords in four victims of blunt traumatic arrest.[6] In this study the amount of force exerted during laryngoscopy was neither quantified nor controlled nor was laryngoscopy compared with other airway manoeuvres with respect to spinal movement. In two of the four victims the injury was so devastating as to have transected the spinal cord at the site of injury and this may not be a representative model for living, salvageable victims of blunt trauma. Any airway manoeuvre undertaken results in spinal movement in both injured and normal necks. There are no data to define whether such small amounts of spinal movement elicited during airway manoeuvres are likely to result in secondary neurological injury but clinical experience suggests that they are not and there are now several large patient series published that support the safety of oral tracheal intubation in spine-injured patients.[3,7-9]

The use of manual-in-line stabilization (MILS) to reduce cervical spinal movement during airway manoeuvres has recently been discouraged.[1,2] The concern is that the application of cervical traction may result in spinal overdistraction in the unstable neck and that a neurological injury may result or be compounded by such a manoeuvre. It is recognized that excessive traction applied to the spinal column for the purposes of stabilization may cause overdistraction and neurological deterioration.[10,11] However, distraction occurs as a necessary result of traction applied to the neck in order to effect reduction of fracture-dislocations and maintain spinal alignment. Overdistraction, on the other hand, is most likely to occur in fracture-dislocations in which all of the ligamentous structures of both the anterior and posterior columns have been disrupted and in this setting, ascending neurological deficit has been reported.[12] Limiting the applied traction to 20–25 kg, applied incrementally, with careful radiographic and clinical observation has been recommended to prevent overdistraction in such an injury. Bivins has demonstrated that traction on the cervical spine is capable of causing distraction and subluxation at the site of injury in victims of blunt traumatic arrest.[6] However, in his model, using an arm traction device and a head-halter, 21.8 kg of traction were applied. In two of the four cadavers studied the injury had transected the spinal cord and presumably had disrupted all the cervical ligamentous structures as well. Care must be taken during the application of spinal traction devices to avoid overdistraction and the patients should undergo both serial radiography to monitor spinal distraction and repeated clinical examination to assure a stable neurological state. However, the goal of MILS is to stabilize the neck through a dynamic interplay between traction and immobilization such that an ideal amount of force is applied to offset the forces generated by the intubator. Forces such as those described by Bivins should never be required or applied for the purposes of MILS. Finally, Majernick has demonstrated that MILS applied by an assistant reduced cervical spinal movement during oral tracheal intubation in normal patients and that MILS was more effective than a Philadelphia collar in reducing spinal movement.[12]

We reviewed elective intubation in 150 patients with unstable cervical spines and minimal neurological injury. We chose patients presenting for elective stabilization procedures because these patients had undergone a complete preoperative neurological examination and had a well-defined neurological status. As well, we reviewed only those patients that had either minimal or no neurological deficit so that the overall effect of intubation, anaesthesia and surgery on neurological function in this patient population could be assessed. Two of our patients (1.3%) suffered deterioration in their neurological status perioperatively, one permanent and one transient. Meschino, in a report advocating the safety of awake tracheal intubation in 136 patients with cervical spinal injury, documented a 2.2% incidence of worsening neurological status between initial examination and discharge, an incidence similar to ours.[3] The Cervical Spine Research Society, in a published review of 5,356 major cervical spinal procedures, reported an overall incidence of neurological complications of 1.04%, again very similar to our complication rate.[14] No complication presumed to be related to intubation was noted in the Society's report.

There are some limitations to our study. Because of its retrospective nature we are reliant on the charts to obtain outcome variables. However, it is our impression that, in this patient population, preoperative and postoperative neurological status were carefully assessed and clearly recorded. Therefore, we are satisfied that the outcome measurement of neurological morbidity could be adequately measured even in a retrospective review. However, the incidence of both difficult intubation and the use of cervical spinal stabilization may well be underreported. Another concern is the number of patients reviewed. If we accept that a 2% complication rate following intubation, anaesthesia and surgery as the norm, then to be certain ($P < 0.05$, $\beta = 0.2$) that any given airway manoeuvre did not increase the complication rate to 4%, thus doubling the morbidity, we would need to study approximately 1800 patients. Clearly no centre can produce patients on such a scale but national reviews such as that conducted by the Cervical Spine Research Society may do so.[14]

In conclusion, oral tracheal intubation did not adversely affect neurological function whether performed with the patient awake or under general anaesthesia in a population of patients with trauma-induced cervical spinal instability presenting for elective operative stabilization. The admonition to avoid oral tracheal intubation in spine-injured patient remains unfounded. The use of in-line stabilization during intubation in this patient population did not result in increased morbidity in this study. This study reviewed elective intubation and the data may not be strictly applicable to emergency intubations in spine-injured patients under suboptimal conditions. Airway management in patients with known or suspected cervical spinal injury should be dictated by common sense and care and not by a dogmatic approach and reliance on any particular algorithm. This statement is supported by the accumulated clinical experience in the management of these patients, in many centres, with a variety of techniques.

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