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BRIEF REPORT

Emergency Medical Services

Change from semi-rigid to soft collars for prehospital management of trauma patients: An observational study

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Abstract

Objectives: Protection of the cervical spine is recommended following multisystem injury. In 2021, Ambulance Victoria changed clinical practice guidelines to apply soft collars instead of semi-rigid collars for suspected cervical spine injury. The aim of this study was to describe associated changes in imaging practices and diagnoses of pressure sores, hospital acquired pneumonia, and spinal cord injury.

Methods: A retrospective pre- and postintervention study was conducted including all consecutive patients that presented to an adult major trauma center in Melbourne, Australia with a cervical collar placed by emergency medical services over two 3-month periods.

Results: There were 1762 patients included. A computed tomography (CT) of the cervical spine was performed in 795 (88.4%) patients in the semi-rigid collar period and 810 (93.8%) in the soft collar period ($p = 0.001$). Soft collars were associated with higher rates of clearance of the cervical spine in the emergency department (ED) (odds ratio [OR] 4.14; 95% confidence interval [CI]: 3.36–5.09). There were no differences in diagnosis of pressure sores (0.11% vs. 0.23%, $p = 0.97$) or hospital acquired pneumonia (2.0% vs. 2.7%; $p = 0.44$) or cervical spinal cord injury (0.45% vs. 0.81%; $p = 0.50$).

Conclusions: Following a change from prehospital semi-rigid collars to soft collars, more patients were investigated with a CT scan and more frequent clearance of the cervical spine occurred in the ED. There were no differences in the rates of spinal cord injuries, pressure sores or hospital acquired pneumonia, but the study was underpowered to detect significant differences. The practice of soft collars for prehospital care of patients with suspected neck injury requires ongoing surveillance.

KEYWORDS
collar, emergencies, emergency medical services, spine-cervical, wound and injuries

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1 | INTRODUCTION

1.1 | Background

Spinal cord injury (SCI) is a devastating injury that carries a high rate of morbidity and mortality. In Victoria, over a 10-year period, there were 706 cases of traumatic SCI, most being the result of transport events (269 cases, 38%) or low falls (197 cases, 28%), with an annual rate of approximately 70 cases per year.[1] Semirigid collars were used to ensure that a patient with an unstable neck injury due to a fracture or ligamentous tear did not injure their cervical spinal cord with head movement during transport to the emergency department (ED).

However, the application of a semi-rigid collar is often uncomfortable, and many conscious patients have difficulties with speaking and swallowing after collar placement.[2] In addition, these collars may be harmful in unconscious patients with traumatic brain injury, since a semi-rigid collar may increase intracranial pressure due to pressure on the jugular vein.[3,4] This venous compression may lead to decreased cerebral perfusion pressure which could have an adverse effect on outcome. Finally, semi-rigid collars may lead to pressure area injury or hospital-acquired pneumonia, especially in the elderly.[5] These complications are presumably due to immobilization, and associated hypoventilation, and potentially due to dysphagia and aspiration.[2,6,7]

1.2 | Importance

In 2016, the Australian Resuscitation Council recommended against semi-rigid collars being fitted by first responders, and that ambulance services review the role of semi-rigid collars with a proposal that these be removed based on questionable efficacy.[8–10] Subsequently, Queensland Ambulance Service and St Johns Ambulance Service (New Zealand) were the first to remove semi-rigid collars for patients with suspected SCI, followed by New South Wales and Western Australia ambulance services.[11] Based on the above changes, Ambulance Victoria moved to the application of a soft collar for patients with suspected neck injury during 2021. The effect of this change was important to measure given the critical importance of management of the cervical spine after injury.

1.3 | Goals of this investigation

The aim of this study was to report differences in imaging of the cervical spine, clearance of the cervical spine, the diagnosis of cervical SCI, pressure sores, and hospital-acquired pneumonia rates before and after the introduction of soft collars (Figure 1).

The Bottom Line

A change in pre-hospital practice of cervical spine protection from semi-rigid to soft collars was associated with more imaging of the cervical spine, and also clearance of the cervical spine in the emergency department. There were no differences in the rate of spinal cord injury, pressure sores or hospital acquired pneumonia after the change to soft collars.

2 | METHODS

2.1 | Study design and setting

A pre-post intervention study was performed. The Alfred Hospital is an adult tertiary referral hospital in metropolitan Melbourne, Australia, with a level 1 trauma center. It receives approximately 1500 major trauma patients per year. Ambulance Victoria is the sole provider for acute prehospital care in the state of Victoria. During the study period, there was no change to any clinical guidelines or policy on cervical spine clearance.

2.2 | Selection of participants

Patients who had the "procedure" of cervical collar placement during the study periods were identified from the Victorian Ambulance Clinical Information System.

2.3 | Exposures

We included all patients transported by ambulance to the single center with a collar in the preintervention (semi-rigid) period of October 01, 2019–December 31, 2019, and the postintervention (soft collar) period of October 01, 2021–December 31, 2021. The time periods were immediately prior to the intervention and the same postintervention period to avoid seasonal changes in injury and disease demographics. During the soft collar period, all semi-rigid collars were removed from ambulances.

2.4 | Measurements

Identifiable information, being the patients' names, date of birth, and date and time of presentation, were extracted and matched to hospital medical records. A chart review of electronic hospital medical records was performed to extract data on demographics, injury characteristics, management, and patient outcomes. Variables were explicitly and objectively defined and extracted by four investigators (C.Y., A.S., C.S., and C.K.). We did not test for inter-rater reliability. Pain scores are routinely recorded using an 11-point visual analogue scale, with a score of 0 classified as no pain and 10 being worst pain possible.

The proportion of patients with cervical SCI was defined by the International Classification of Diseases-10 code (S14.109A) and restricted to the cervical spine. Specifically, the injury had to be accompanied by loss of function, movement, and/or sensation. We reported the proportion of patients who underwent CT of the cervical spine, had

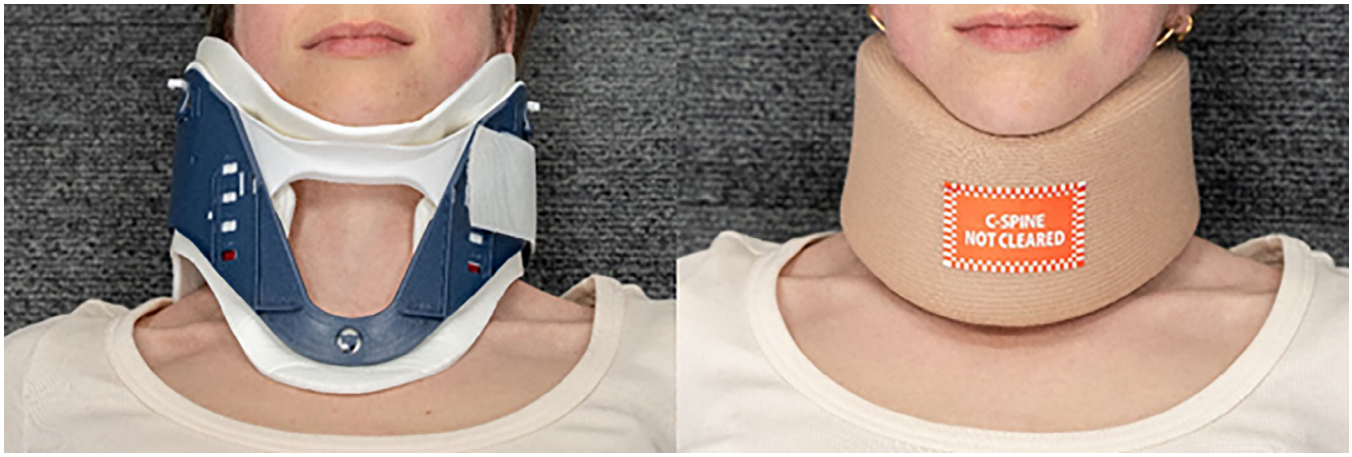

FIGURE 1 Semi rigid and soft collars.

clearance of their cervical spine in the ED, and the rates of pressure sores and hospital-acquired pneumonia. Spinal clearance occurred when relevant clinicians had examined the patient, and with or without radiology, they determined that no clinically significant injuries existed and immobilization procedures could be ceased. Pressure sores and hospital-acquired pneumonia were coded if diagnosed at hospital discharge, and not recorded as an admission diagnosis.

2.5 | Analysis

Baseline variables were categorized and compared using the chi-square test. The association of soft collars and imaging rates, cervical spine clearance, pressure sores, hospital-acquired pneumonia, and SCI were presented using univariable odds ratios with 95% confidence intervals, and adjusted odds ratios (aOR) after adjustment for differences in baseline characteristics. All analyses were conducted using Stata v18.0 (College Station). A p-value of <0.05 was defined to be statistically significant. The project was approved by The Alfred Hospital Human Research and Ethics Committee (Project ID 143/21) and Ambulance Victoria Research Governance (Project ID R21-004). The requirement to seek informed consent from patients was waived.

3 | RESULTS

There were 899 eligible patients in the preintervention period and 863 in the postintervention period. Baseline characteristics are listed in Table 1. Patients in the soft collar period were older and were more commonly injured from falls.

3.1 | Imaging and clearance

A CT of the cervical spine was performed in 795 (88.4%) patients in the semi-rigid collar period and 810 (93.8%) in the soft collar period (OR 2.0; 95% confidence interval [CI]: 1.42–2.82, $p < 0.001$) that remained statistically significant after adjustment (aOR 1.92; 95% CI: 1.35–2.72, $p < 0.001$) There were 75 (8.4%) patients who had magnetic resonance imaging (MRI) of the cervical spine at any time during the index hospital presentation in the preintervention period and 89 (10.3%) in the postintervention period (OR 1.26; 95% CI: 0.92–1.75, $p = 0.15$ and after adjustment aOR 1.24; 95% CI: 0.89–1.73, $p = 0.19$). On discharge from the ED, in the preintervention period, a collar was present in 478 (53.2%) patients and 186 (21.6%) after the intervention (OR 0.24; 95% CI: 0.20–0.30, $p < 0.001$). Most (98.6%) were discharged to inpatient wards with nine patients discharged home in collars. After adjustment, the association remained statistically significant (aOR 0.24; 95% CI: 0.19–0.29, $p < 0.001$).

3.2 | Diagnoses

Spinal cord injuries were detected in four (0.44%) patients in the preintervention period and seven (0.81%) in the postintervention period (OR 1.83; 95% CI: 0.53–6.29, $p = 0.50$). After adjustment for age categories and mechanisms of injury, the association of soft collars and cervical SCI was not statistically significant (aOR 1.51; 95% CI: 0.43–5.27). Clinical characteristics of patients with cervical SCI are presented in Table S1. There were no differences in the proportion of pressure sores diagnosed (0.11% vs. 0.23%, $p = 0.97$) or hospital-acquired pneumonia (2.0% vs. 2.7%; $p = 0.44$) (Table 2).

4 | LIMITATIONS

This study is limited in being a snapshot over two time periods. Given the low rate of cervical SCI, it was not possible to power the study to a clinically significant difference. The added challenge of an adequately powered study is that the clinically significant difference would be very small and the primary outcome (cervical SCI) may have occurred prior to the intervention (collar). SCI is the most important clinically significant outcome to monitor when changes are made to clinical practices

TABLE 1 Baseline characteristics.

Variable	Pre-intervention ($n = 899$)	Post-intervention ($n = 863$)	p-value[a]
Age			<0.001
≤25 years	156 (17.4%)	111 (12.9%)	
26–50 years	300 (33.4%)	239 (27.7%)	
51–65 years	163 (18.1%)	179 (20.7%)	
>65 years	280 (31.1%)	334 (38.7%)	
Gender			0.85
Female	342 (38.0%)	332 (38.5%)	
Male	557 (62.0%)	531 (61.5%)	
Mechanism of injury			0.002
Motor vehicle crash	210 (23.4%)	160 (18.5%)	
Motorbike crash	57 (6.3%)	68 (7.9%)	
Pedestrian	36 (4.0%)	28 (3.2%)	
Cyclist	83 (9.2%)	69 (8.0%)	
Low fall (standing height)	309 (34.4%)	336 (8.9%)	
High fall	73 (8.1%)	106 (12.3%)	
Assault	63 (7.0%)	43 (5.0%)	
Other[b]	68 (7.6%)	53 (6.1%)	
Initial Glasgow Coma scale			0.75
3–8	32 (3.6%)	32 (3.8%)	
9–12	22 (2.5%)	26 (3.1%)	
13–15	829 (93.9%)	789 (93.1%)	
Missing	16	16	
Prehospital intubation	32 (3.6%)	27 (3.1%)	0.88
Cervical vertebral fracture	41 (4.6%)	35 (4.1%)	0.60

[a]Calculated using the chi-square test.
[b]Animal-related injuries, machinery injuries, and train crashes.

TABLE 2 Outcome measures associated with soft collars.

	Preintervention ($n = 899$)	Postintervention ($n = 863$)	Odds ratio (95% CI)[a]	p-value
Spinal cord injury	4 (0.44%)	7 (0.81%)	1.83 (0.53-6.28)	0.50
Pressure sores	1 (0.11%)	2 (0.23%)	2.08 (0.19-23.02)	0.97
Hospital acquired pneumonia	18 (2.0%)	23 (2.7%)	1.30 (0.72-2.50)	0.36
Computed tomography imaging	795 (88.4%)	810 (93.9%)	2.0 (1.42-2.82)	<0.001
Magnetic resonance imaging	75 (8.3%)	89 (10.3%)	1.26 (0.92-1.75)	0.15
Collar on discharge	478 (53.2%)	186 (21.5%)	0.24 (0.19-0.30)	<0.001

[a]Univariable analysis.
Abbreviation: CI, confidence interval.

of spinal protection. This was a single center study which limits generalizability. However, as a major trauma center, there were likely to be a higher number of patients with SCI patients than other centers. The complications of pressure sores and hospital-acquired pneumonia that had been observed in older patients appear limited in the overall population.[12]

5 | DISCUSSION

Following introduction of soft collars, more patients were investigated with CT of the cervical spine, but also more patients had clearance of the cervical spine in the ED. There were no differences in the rates of cervical spinal cord injury, pressure sores, or hospital-acquired

pneumonia after transition from prehospital semi-rigid collars to soft collars.

The results confirm the experience when collars were changed from semi-rigid to soft collars in New South Wales.[13] Similar to our experience, the onset of new symptoms of cervical SCI in NSW was very low, and the use of soft foam cervical collars did not appear to increase the risk for secondary SCI. Similarly, a Cochrane review of 4453 potentially relevant articles found no randomized controlled trials to support the use of spinal immobilization in patients with suspected neck injury following blunt or penetrating trauma.[14] Additionally, cervical collars have been associated with adverse effects such as increased respiratory effort, skin ischemia, and pain.[8]

The hypothesis that soft collars could enable clearance of the cervical spine without the need for a CT was disproven. On the contrary, more CT scans were requested in the postintervention period. While there were no explicit changes to clinical practice guidelines on imaging for the assessment of cervical spine injury, it is possible that this difference in CT scanning was associated with a change in practice toward more imaging for the assessment of injured patients, and not due to the change in type of collars.

The key rationale for semi-rigid collars was to prevent neck movement, which may thus prevent SCI in a patient with an unstable neck fracture. If neck movement was to occur and this led to SCI, there would be substantial medical, social, economic, and psychological sequelae. The potential harm of immobilization with a semi-rigid collar must therefore be carefully balanced against the significant costs of SCI, which may occur in the prehospital phase. On the other hand, there is limited evidence that semi-rigid collars prevent neck movement, and no association has been established between lack of a semi-rigid collar and subsequent development of SCI.[7,15]

Therefore, ongoing surveillance of SCI is essential to monitor any adverse effects of the use of soft collars. Victoria's State Trauma Registry is ideally placed to monitor and evaluate all cases of SCI. With an estimate of having to immobilize between 625 and 3333 patients to prevent one exacerbation of injury, larger prospective studies are required before a robust conclusion on safety can be confirmed.[16] In conclusion, there were no differences in the rates of SCI, pressure sores or hospital-acquired pneumonia after a change of prehospital practice from semi-rigid collars to soft collars. There were more CT scans of the cervical spine performed among patients managed with a soft collar, but also a higher rate of clearance of the cervical spine in the ED. While this preliminary report supports the safety of the change to soft collars for prehospital care of patients with suspected neck injury, ongoing analysis of the impact on spinal cord injury is required.

AUTHOR CONTRIBUTIONS

Biswadev Mitra: Conceptualization; data collection; data analysis; critical review and evaluation of results; primary authorship of the paper; review and editing of the paper; study supervision; procurement of grant. **Stephen Bernard**: Conceptualization; critical review and evaluation of results; study supervision; procurement of grant. **Cassandra Yankoff**; **Abha Somesh**; **Cara Stewart**; **Christine Koolstra**; and **Carly Talarico**: Data collection; critical review and evaluation of results; study supervision. **Ziad Nehme** and **Mark C. Fitzgerald**: Conceptualization; critical review and evaluation of results; review and editing of the paper. **Peter A. Cameron**: Critical review and evaluation of results; review and editing of the paper; study supervision.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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REFERENCES

1. Beck B, Cameron PA, Braaf S, et al. Traumatic spinal cord injury in Victoria, 2007–2016. *Med J Aust*. 2019;210(8):360-366.
2. Jarvis S, Sater A, Gordon J, et al. Cervical collars and dysphagia among geriatric TBIs and cervical spine injuries: a retrospective cohort study. *J Healthc Qual*. 2023;45(3):160-168.
3. Hunt K, Hallworth S, Smith M. The effects of rigid collar placement on intracranial and cerebral perfusion pressures. *Anaesthesia*. 2001;56(6):511-513.
4. Karason S, Reynisson K, Sigvaldason K, et al. Evaluation of clinical efficacy and safety of cervical trauma collars: differences in immobilization, effect on jugular venous pressure and patient comfort. *Scand J Trauma Resusc Emerg Med*. 2014;22:37.
5. Ham W, Schoonhoven L, Schuurmans MJ, et al. Pressure ulcers from spinal immobilization in trauma patients: a systematic review. *J Trauma Acute Care Surg*. 2014;76(4):1131-1141.
6. Hudson MAJ, Ehsanullah J, Lee A, et al. In healthy volunteers the Miami-J® cervical collar causes swallow dysfunction. This may increase the risk of aspiration; of particular potential consequence in older people with neck injury. *Interdisciplinary Neurosurg*. 2023;33:101788.
7. Brannigan JFM, Dohle E, Critchley GR, et al. Adverse events relating to prolonged hard collar immobilisation: a systematic review and meta-analysis. *Global Spine J*. 2022;12(8):1968-1978.
8. Hood N, Considine J. Spinal immobilisaton in pre-hospital and emergency care: a systematic review of the literature. *Australas Emerg Nurs J*. 2015;18(3):118-137.
9. Hauswald M. A re-conceptualisation of acute spinal care. *Emerg Med J*. 2013;30(9):720-723.
10. Leman P, Morley P. Review article: updated resuscitation guidelines for 2016: a summary of the Australian and New Zealand Committee on Resuscitation recommendations. *Emerg Med Australas*. 2016;28(4):379-382.

11. Rashford S, Schultz BV. Is it finally time we stick our neck out? *Emerg Med Australas*. 2021;33(1):4-5.
12. Nakanishi T, Mitra B, Ackland H, et al. Time in collars and collar-related complications in older patients. *World Neurosurg*. 2019;129:e478-e484.
13. Asha SE, Curtis K, Healy G, et al. Neurologic outcomes following the introduction of a policy for using soft cervical collars in suspected traumatic cervical spine injury: a retrospective chart review. *Emerg Med Australas*. 2021;33(1):19-24.
14. Kwan I, Bunn F, Roberts I. Spinal immobilisation for trauma patients. *Cochrane Database Syst Rev*. 2001;2001(2):Cd002803.
15. Bäcker HC, Elias P, Braun KF, et al. Cervical immobilization in trauma patients: soft collars better than rigid collars? A systematic review and meta-analysis. *Eur Spine J*. 2022;31(12):3378-3391.
16. Sundheim SM, Cruz M. The evidence for spinal immobilization: an estimate of the magnitude of the treatment benefit. *Ann Emerg Med*. 2006;48(2):18-19. 217-8; author reply.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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