

Selected Topics: Emergency Radiology



RADIATION EXPOSURE AS A CONSEQUENCE OF SPINAL IMMOBILIZATION AND EXTRICATION

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Abstract—Background: Extrication and spinal immobilization in the trauma patient with unknown injuries is a common practice of emergency medical services. High-speed crashes occurring in open-wheel racing seldom result in extrication or spinal immobilization. **Objectives:** To evaluate the safety of self-extrication in IndyCar® (Indianapolis, IN) by comparing drivers self extricated with full spinal immobilization and subsequent radiation exposure. **Methods:** A retrospective review of prospectively collected de-identified IndyCar® crash and drivers' medical records was performed at treating Level I trauma centers. One hundred thirty-five crash incidents involving drivers evaluated by a medical team were included. Any driver with severe multiple trauma was excluded due to distracting injuries. Drivers underwent standard protocol for postcrash injury. Diagnostic and treatment outcomes including spinal and neurologic injury, need for surgery, and radiation exposure were collected for review. **Results:** Self-extrication occurred in 121 (90%) crashes, and overall cumulative radiation exposure ranged from 100 to 250 mSv, or 0.82–2.06 mSv per driver. Extrication with full spinal immobilization

occurred in 14 (10%) drivers, with overall cumulative radiation exposure ranging from 140 to 350 mSv, or 10–25 mSv per driver. A total of 29 injuries were identified, nine of which (31%) were spinal. In these, six were emergency medical services extricated and three self extricated. None were unstable spinal fractures resulting in surgical care, surgical disease, or neurologic deficit. **Conclusion:** In our IndyCar® racing experience, a protocol-led self-extrication system resulted in neither a mismanagement of an unstable spinal fracture nor neurological deficit, and reduced radiation exposure. © 2015 Elsevier Inc.

Keywords—emergency department; imaging; computed tomography; magnetic resonance imaging; trauma

INTRODUCTION

Emergency Medical Services (EMS) focuses on rapid assessment and transportation of motor vehicle crash victims. Patients with serious “mechanism of injury” are extricated from the vehicle and placed in spinal immobilization. This practice has basis in EMS principles developed decades ago at a time before restraint systems, airbags, and computed tomography (CT) scans were present (1–5). In contrast, drivers in the IndyCar® Racing Series (Indianapolis, IN) involved in high-speed (often > 200 mph) accidents commonly self extricate and are

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often transported to medical facilities without cervical collars or backboards.

Currently, the need for spinal immobilization in a conscious, cooperative, neurologically intact patient is being questioned (6–8). Mechanism of injury has been shown to be an unreliable indicator of spinal injury (9). Spinal immobilization is not benign nor without cost. Complications from spinal immobilization including airway compromise, skin pressure injury, and painful manipulation are well documented in the literature (10–13). It is common for patients immobilized due to serious mechanism to receive whole-body CT, so-called “pan-scan,” to rule out life-threatening injuries (14). A consequence that is not routinely considered in pan-scan-driven patient evaluation is exposure to ionizing irradiation, the result of unnecessary CT. In our study we evaluate the safety of self extrication in IndyCar® by comparing drivers self extricated to those with EMS-facilitated extrication as indicated by spinal injury, need for surgery, and neurological outcomes. A secondary goal was to quantify the use and potential radiation risk of CT imaging for spine injuries in this race car driver population.

MATERIALS AND METHODS

We conducted a retrospective review of prospectively collected de-identified IndyCar® crash and drivers’ medical records during the years 2006–2011. This time period is important as it represents a period when multiple driver protection strategies had been implemented, including: mandatory use of Head and Neck Support (HANS®; HANS Performance Products, New

Braunfels, TX) device by all drivers; unified chassis design across the racing series, which included energy-absorbing head surrounds, rear impact attenuators, and enhanced energy-absorbing seat design specifications; and league rules that all high-speed oval track venues install Steel And Foam Energy Reduction (SAFER®; Motorsports Safety Technology, Indianapolis, IN) barriers. Inclusion criteria were involvement in a crash incident and evaluation by the medical team. One driver was excluded due to apparent nonsurvivable injuries on the scene. We examined 456 individual crash incidents and identified 135 meeting inclusion criteria. Cumulative CT imaging, need for surgery, and reported neurologic outcomes were obtained from medical records. All of the drivers with spinal injury were assessed and treated by the same spine surgeon.

RESULTS

In our series, 29 drivers (21.5%) had a diagnosis of back or spine injury. Nine (6.67%) were diagnosed with burst, compression, chip, endplate, dislocation, or transverse process fractures (Table 1) (15–17).

Self-extrication occurred in 121 (89.6%) incidents, with three spinal fractures in this group. During this study period, 14 (10.4%) drivers were EMS extricated and immobilized, with six spinal fractures in this group. None of the nine spine fractures required surgical stabilization nor had a neurological deficit (Figure 1).

In this same 5-year time period, there were 29 incidents with concern for back or spine injury: 25 receiving CT imaging of spine by neck, chest, abdomen, and pelvis CT (pan-scan) with reconstruction or dedicated spine CT. In

Table 1. Spinal Injuries

Year	Track Type	Impact Direction	Fracture Level	Fracture Type*	Degrees Wedging	% Compression	Severity Index†	TLICS Index‡
2006	O	F	L2/L3	Fx-D§	N/A	N/A	6	8
2007	O	R	T2, T5, T6	A	<10%	<10%	1	1
2008	O	R	C4–5, -T1/2	N/A	N/A	N/A	1	2
2009	O	F	L1, L2	B1	18	40%	4	5
2009	PRC	F	L2, L3, L4	A2	5	12%	2	1
2010	O	V	T3	A	14	20%	3	1
2011	PRC	V	T5	A	14	36%	4	1
2011	O	R	C7	A	18	17%	3	1
2011	O	V	T4	A	18	18%	3	1

O = Oval; PRC = Permanent Road Course; F = Frontal; R = Rearward; V = Vertical; TLICS = Thoracolumbar Injury Classification and Severity Score.

Average driver age was 35 years (range, 22–61 years) with 92% of drivers (n = 81) being male.

* Fracture type is the Gertzben Classification from: Gertzben SD. *Fractures of the Thoracic and Lumbar Spine*. Baltimore, MD: Williams and Wilkins; 1992 (15).

† Severity Index: based on the degree of wedging and the % compression of a compression fracture (Level 1–4) with injury to the posterior ligamentous complex (Level 5) and fracture dislocation (Level 6). Trammell TR, Weaver CS, Bock H. Spine Fractures in Open Cockpit Open Wheel Race Car Drivers. SAE Technical Paper 2006-01-3630 (16).

‡ TLICS Score from the Spine Trauma Study Group 2005. Vaccaro AR, Baron EM, Sanfilippo J, et al. Reliability of a novel classification system for thoracolumbar injuries: the Thoracolumbar Injury Severity Score. *Spine* 2006;31(11 Suppl):S62–9 (17).

§ This driver sustained unsurvivable injuries; he was extracted with full spinal immobilization. Spinal fracture was noted on plain radiographs and postmortem examination.

|| Driver sustained soft tissue injury including hemorrhage into the supraspinous and interspinous ligaments without complete disruption, but no vertebral fracture.

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