



# Is operative management of fractures safe in the collocated burn and fracture injury?



Luke Bradshaw<sup>a,\*</sup>, Jason Wasiak<sup>b</sup>, Heather Cleland<sup>a,c</sup>

<sup>a</sup>Victorian Adult Burns Service, The Alfred Hospital, Commercial Road, Melbourne, Victoria, Australia

<sup>b</sup>Victorian Adult Burns Service and School of Public Health and Preventive Medicine, Monash University, The Alfred Hospital, Melbourne, Victoria, Australia

<sup>c</sup>Department of Surgery, Central and Eastern Clinical School, Monash University, Melbourne, Victoria, Australia

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## ABSTRACT

**Aims:** To review the management of a collocated major fracture and dermal burn injury in adult multi-trauma patients. In particular, this study examines the methods and timing for fracture fixation and the fracture complications observed.

**Methods:** A retrospective chart review of all patients admitted to the Alfred Hospital, Melbourne, Australia from January 2000 to December 2012 with a collocated dermal burn and major fracture.

**Results:** Of the 22 patients included (median abbreviated injury score-98 of 22 and total burn surface area of 8%), 17 underwent operative fracture fixation. Eleven patients had internal fixation, two had external fixation and four had temporary external fixation with delayed internal fixation. Median time to operative fixation was 5.7 h (interquartile range: 3.5–16.8), with 15 of the 17 patients undergoing fixation within 24 h. Nine patients experienced a fracture complication. Five patients had an infective fracture complication (wound infection or osteomyelitis), and all of these patients had had internal fixation. No fracture complications occurred in patients managed conservatively.

**Conclusion:** Previous studies have supported the use of internal fixation for early mobility and simplified wound care. However, we observed a high rate of fracture complications with internal fixation, despite undergoing management within 24 h of presentation. At this point, we are unable to conclude on the safety of utilising internal fixation in the collocated injury.

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## Introduction

Combined burn and fracture injury is an uncommon occurrence in the multi-trauma patient. Multi-trauma patients have conflicting priorities that multiple teams have to work through [1]. These include the order in which injuries are managed, how each injury is managed and the timing of such management [2–7]. In the setting of a collocated burn and fracture injury the method and timing of the fracture treatment directly impacts the burn treatment and vice versa. Currently, there are no management guidelines regarding collocated dermal burn and fracture injuries, when the safety of performing internal fixation through burned skin with the risks of infection and prosthesis contamination is a particular issue [8,9].

Evidence has evolved from animal models to clinical reviews to address the balance of burn and fracture treatment [2–7]. Much evidence has paralleled the orthopaedic trend to internal fixation (ORIF), because definitive reconstruction allows early mobilisation and simplified soft tissue management [3]. Grisolia et al. [2] utilising an animal model in 1963 challenged the burn first, fracture second (if at all) traditional management, suggesting that it was possible to manage these injuries with internal fixation early to minimise infection. Novak et al. [6] in 1977 reviewed 78 multi-trauma burn patients and recommended concurrent early ORIF and debridement and graft. Choctaw et al. [7] in 1979 presented a limited case series and advocated early burn management with non-operative fixation. In clinical cohort studies, Saffle et al. (1983) and Dossett et al. (1991) recommended definitive fixation within 48 h, when bacterial colonisation is low [3,4]. Other authors also support early fixation in conjunction with burn debridement [1,8,9].

In this study, we aim to review the management of collocated burn and fracture injuries on adult multi-trauma patients. In particular, this study examines the timing of fracture interventions and fracture complications in these patients.

\* Corresponding author at: Victorian Adult Burns Service, The Alfred Hospital, P.O. Box 315, Prahran, Victoria 3181, Australia. Tel.: +61 3 9076 3626.  
E-mail address: [drlukebradshaw@gmail.com](mailto:drlukebradshaw@gmail.com) (L. Bradshaw).

**Table 1**  
Patient injury summary (22 patients).

Age	31 (23–47)
Male	20
Mechanism of injury	
Motor vehicle accident	9
Motor cycle accident	5
Flame or explosion	3
Pedestrian	2
Other	3
Body region of collocated injury	
Leg	7
Forearm	6
Thigh	3
Back	4
Pelvis	1
Ankle	1
Associated injuries	
Head	8
Face	7
Chest	9
Intra-abdominal	2
Spine	5
Non-collocated fracture	3
Hospital outcomes	
Length of stay (days)	31.5 (20.75–70.25)
Admission to ICU	14
ICU length of stay (days)	18.5 (10.25–47.25)
Discharge to rehabilitation facility	19
Unplanned readmission	4
Hospital events	
Operative fracture management	17
Operative burn management	20
Blood transfusion	13
Thromboembolic event	3
Endotracheal intubation	15
Immediate escharotomy	6
Immediate fasciotomy	9

NB: data are median (inter-quartile range) or number.

## Methods

### Study setting

The Victorian Adult Burns Service (VABS) is a state-wide adult burns service located at the Alfred Hospital, which also provides a state-wide adult major trauma service. The Australian state of Victoria has a population of approximately 5.55 million people. It has a highly organised and centralised trauma system. Approximately 98% of all severely injured adult burn patients in the state are managed at the VABS, which admits approximately 300 new burn patients annually [10].

### Ethics

Approval was obtained from our hospital's human research and ethics committee as a low risk quality improvement project.

**Table 2**  
Conservative fracture management (5 patients).

Age (yr)	Fracture	AIS-98	TBSA	Burn treatment	Fracture/burn complication	Fracture/burn MCS	Time to burn debridement (h)	Time to burn reconstruction (h)
31	Ulna (open)	43	95	SSG	Burn – infection	Burn – MRSA, <i>E. coli</i> , MBL	0.9	>6 weeks
59	Radius (Colles)	43	40	SSG	Burn – infection, graft loss	Burn – Bacillus species	12.4	6.7
18	Clavicle and scapular	21	7	SSG	Burn – infection, graft loss	Burn – MSSA	21.2	21.2
24	Tibia/fibula	14	2	Dressings	NA	NA	NA	NA
61	T3 compression	48	6	SSG	NA	NA	1.9	363
Median							7.2	

AIS-98, Abbreviated Injury Score-98 [11]; TBSA, total burn surface area (%); MCS, microscopy/culture/sensitivity; SSG, split skin graft; *E. coli*, *Escherichia coli*; MRSA, methicillin-resistant *Staphylococcus aureus*; MBL, metallo-beta-lactamase (MBL) serratia; MSSA, methicillin-sensitive *Staphylococcus aureus*; NA, not applicable.

## Definitions

A major fracture was defined as “a fracture of a long bone or a bone that affects weight bearing” [3]. A collocated injury was defined as a dermal burn overlying a fracture. AIS-98, rather than AIS-2005 or AIS-2008, was used as a multi-trauma injury scale, as the scale was in clinical use throughout the entire study period [11].

## Data collection

A retrospective chart review of all patients admitted to the Alfred Hospital from January 2000 to December 2012 with a collocated dermal burn and major fracture injury was undertaken. Patient exclusion criteria were: non-major fracture; non-collocated injury; or significantly incomplete or unavailable medical record. All collocated burn and fracture injuries were identified using the Alfred Hospital's medical record coding system. A single investigator was used for data collection and collation. Baseline hospital stay outcomes and interventions were collected.

Fracture data points included site, type, collocation, fixation type, operative times and complication (wound infection, osteomyelitis, mal- or non-union and unplanned change of fixation). An unplanned change or revision of fixation was assumed when notation of a fixation complication was present in the pre-operative or operative notes. Wound infection related explicitly to infection of the fracture operative site, including percutaneous pin sites. A wound was considered infected if there were documented clinical signs of infection (e.g. erythaema, induration, discharge). Supporting evidence included wound swabs and interventions (antibiotics or operative debridement).

Burn data points included type of management, operative reconstruction technique, dressings used throughout the admission, and burn complications (burn infection, graft or flap loss).

The hospital record was reviewed for subsequent episodes relating to injury from time of discharge to data collection in March 2013. The follow-up period varied from 2 to 12 years. Data were stored and collated using Microsoft Excel<sup>®</sup>. Continuous variables were reported as means  $\pm$  standard deviations (SD) or medians (interquartile ranges, IQR), depending on the underlying distribution of the data. Categorical variables were presented as count and proportions.

## Results

### Patient demographics and hospital outcomes

A total of 199 patients were identified over the 12-year study period. After review, 177 patients were excluded (101 non-collocated injury, 58 non-major fracture, 16 where there was no burn or fracture and two incomplete records) leaving 22 patients

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