CSOP 025 – Crush Injury

Version No: 1.2 Effective date: 13/06/2022

APPROVALS

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HISTORY

Effective Date	Version No.	Summary of Amendment
Jan 2017	1.0	Creation of document
Jan 2019	1.1	Reviewed, inclusion of calcium in crash management considered
May 2022	1.2	Review of evidence base and mini-scoping review. Removal of reference to suxamethonium as no longer carried.

REFERENCES

Document Reference Number	Document Title

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1. Purpose

Crush injuries hold unique challenges in the prehospital care environment. The aim of this CSOP is to ensure the highest possible standards of care in the management of crush injuries and crush syndrome in the context of other injuries.

2. Scope

This Clinical Standard Operating Procedure forms a component of the procedures for Level 8 Specialist Pre-Hospital Emergency Care (S-PHEC) delivered by the Air Ambulance Service.

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3. Definitions/Acronyms:

Abbreviations/Acronym	Definitions
CSOP	Clinical Standard Operating Procedure
EMAS	East Midlands Ambulance Service
HART	Hazardous Area Response Team
RSI	Rapid Sequence Induction (of Anaesthesia)

4. Background:

A crush injury is defined as “a direct injury resulting from crush”. Crush syndrome is defined as “the systemic manifestation of muscle cell damage resulting from pressure or crushing”.[1]

Crush injuries are rare in civilian practice.[1] They have the potential to occur in the context of industrial accidents, road traffic collisions, building collapse, accidents involving heavy plant and disaster relief or terrorist incidents.[2]

5. Pathophysiology

The typical clinical features of crush syndrome are predominantly a result of traumatic rhabdomyolysis and subsequent release of muscle cell contents, and is otherwise known as Bywaters syndrome.[3]

The severity of the condition is dependent on the duration and magnitude of the crush injury, as well as the bulk of muscle affected.[1] Therefore crush injury is possible both in short duration, high magnitude injuries (such as being crushed by a heavy goods vehicle); as well as lower magnitude injuries of a long duration (such as prolonged entrapment).[4] Crush syndrome has been described following prolonged drug-induced immobility so should be considered in the context of prolonged immobility – e.g. drug induced coma with a long time prior to discovery.

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As the severity of crush syndrome relates to the bulk of muscle injured, crush syndrome is most common following crush injuries to the legs.[1] However, it can occur following injury to the arm and trunk.

6. Complications of Crush Syndrome

a. Hypovolaemic Shock

Loss of plasma volume across disrupted capillary walls and cell membranes can lead directly to significant hypovolaemia.[1] There may also be secondary effects related to myocardial depression and vasodilatation as a result of the release of intracellular electrolytes and compounds.[1] As a result of mechanism of injury, significant major cavity or long bone trauma often co-exists.

b. Hyperkalaemia and electrolyte disturbances

Disruption of cell membranes can result in a significant release of potassium, which is a largely intracellular cation this can precipitate cardiac arrest.[5] Sequestration of plasma calcium into injured tissue can lead to a relative hypocalcaemia, which may worsen coagulopathy and shock. Metabolic acidosis may result from reperfusion injury and hypoperfusion related to shock.

c. Compartment syndrome

Compartment syndrome is a common complication of crush injury as a consequence of oedematous tissue injury, redistribution of fluid into the intracellular compartment and haemorrhage. Established compartment syndrome may result in worsened systemic crush syndrome and irreversible muscle necrosis.[6]

d. Acute renal failure

Release of myoglobin by injured muscle leading to rhabdomyolysis coupled with shock leads to a significant rate of acute kidney injury, estimated as up to 15%,[2] acute kidney injury leads to a significantly higher mortality.

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7. Diagnosis

Crush injury should be suspected if there is a prolonged entrapment or significant mechanism resulting in crush to a large muscle mass.

8. Triage/ Choice of facility

Suspicion of crush injury should trigger transfer to hospital rather than clearance at scene as late complications may develop.[1] Patients with a suspected crush injury should always be taken to a major trauma centre.

9. Management of the trapped casualty

Rescuers should be aware of the risk posed by the incident leading to a casualty becoming trapped, including the risk of further structural collapse. Rescuers should treat only if it is safe to do so.[1,6]

Casualties should be extricated as rapidly as possible, irrespective of the length of time trapped.[1,6] Extrication plans should not end with release of the limb – the casualty should be rapidly moved to the transport vehicle and conveyed with all delays minimised.

Appropriate analgesia should be offered to trapped casualties. This may aid extrication.[1]

10. Fluid resuscitation

Early fluid resuscitation reduces the risk of renal failure, reduces the severity of hyperkalaemia and may improve outcomes in isolated crush injury.[1,6]

For casualties with isolated crush injury who are haemodynamically stable, large volume crystalloid resuscitation reduces the severity of and prevents acute kidney injury.[7]

However if there is strong suspicion of significant multisystem trauma or uncontrolled haemorrhage, resuscitation to usual targets is recommended, including hypotensive resuscitation

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where appropriate, as uncontrolled internal haemorrhage is a more immediate threat to life than a potentially increased risk of renal injury at a later point (which can be reduced later with high volume resuscitation after haemorrhage control in hospital)

The resuscitation regime recommended for prevention of acute kidney injury in isolated crush injury (i.e. where there is no suspicion of significant internal haemorrhage) is as follows:[1]

- An initial bolus of 2 litres of crystalloid (20ml/kg for children)
- Followed by 1-1.5 litres of crystalloid per hour (10-15ml/kg/hr for children)

Sodium Chloride 0.9%, ideally warmed, is recommended in UK prehospital consensus guidelines due to concerns about the potassium content of balanced solutions (such as Hartmann's) worsening hyperkalaemia.[1]

Extrication should not be delayed purely to administer fluids.[1] Consider also if a large volume of fluids prehospital could worsen the clinical state of the patient – for example if there are concerns about haemodilution with ongoing haemorrhage.[6]

11. Electrolyte control

Potassium is a prevalent intracellular cation, which is released following damage to ischaemic tissues. There is the potential for a significant rise in plasma potassium after release which holds the potential to cause cardiac arrest; if such an arrest were to occur hyperkalaemia should be considered as one of the more likely reversible causes. Because of this, in addition to the possibility of hypocalcaemia, consideration should be given to the administration of intravenous calcium chloride (10ml 10% over 5 mins) in crush injury patients at or around the time of release. Some prehospital services may use salbutamol nebulisers, prior to the arrival of TAAS, to drive potassium intracellularly – this may result in tachycardia on initial assessment of the patient.

12. Tourniquets

Tourniquets are not indicated for isolated crush injury in an attempt to delay the release of toxins.[1,8] Tourniquets should only be used if there is another indication for them, such as uncontrolled catastrophic external haemorrhage.

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13. Amputation

Amputation should not be performed for isolated crush injury in order to prevent crush syndrome.[1] A limb should only be amputated pre-hospital if there are other indications. Many crushed limbs which look catastrophically injured pre-hospital may in fact be usefully salvageable on later assessment.[1]

14. Fasciotomy

Fasciotomy to prevent compartment syndrome should not be performed in the prehospital environment as the increase in mortality from sepsis outweighs the benefit in reducing the severity of compartment syndrome.[2]

15. Renal Protection

Other than fluid resuscitation described above there are no other prehospital measures available to TAAS clinicians.[3]

16. Infection Control

Antibiotics (Co Amoxiclav) should be administered prophylactically for open fractures or contaminated wounds if the patient is not penicillin allergic.

17. Oxygen Therapy/ Ventilation Strategies

High flow oxygen is recommended if available as some authors feel it may reduce the severity of tissue hypoxia, but there is no good quality evidence to support this.[2]

If invasive ventilation is required, lung protective ventilation parameters (6ml/kg ideal body weight target tidal volume, PEEP to maintain open lung strategy, Plateau pressures less than 30mmHg, minimal FiO2 to maintain oxygenation), should be used as there is a high incidence of ARDS following crush injury.[2]

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18. Hyperbaric Oxygen

There is no good evidence supporting the use of hyperbaric oxygen for crush injury (Cochrane review).[9] It is therefore inappropriate to specifically transport to a facility offering hyperbaric oxygen therapy in preference to a closer suitable facility.

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