Crush Injury/ Syndrome

Crush injury: localized compression of extremities or other parts of the body that causes muscle injury and/or ischemia resulting in swelling and/or neurological disturbances in the affected areas of the body. If significant muscle mass is involved it can lead to Crush Syndrome.

Crush syndrome: systemic manifestations caused by crushed muscle tissue. This is a potentially life-threatening systemic condition. These systemic effects are caused by a traumatic rhabdomyolysis (muscle breakdown) and the release of potentially toxic muscle cell components into the circulatory system, causing local tissue injury, organ dysfunction, and metabolic abnormalities, including acidosis, hyperkalemia, and hypocalcemia.

SIGNS AND SYMPTOMS:

- Painless crushed extremity (Paraesthesia, Hyperesthesia, Hypoaesthesia, Anesthesia)
- Pain
- Absent distal pulses
- Agitation
- Decreased muscle function / paralysis – may be confused with spinal injury.
- Progressively marked swelling of the area
- Hypotension
- Massive third spacing occurs (compartment syndrome)
- Renal Failure
- Metabolic Abnormalities – hypocalcemia, hyperkalemia, metabolic acidosis
- ECG Dysrhythmias
- Severe pain in crushed extremity after release
- Mottled or blistered skin
- Edema
- Reddish/ Brown urine

TREATMENT

1. **Follow Crush Injury Protocol**
2. Follow **General Pre-Hospital Care Protocol**
3. Protect the c-spine, per **Spinal Precautions Protocol**, as indicated
4. Identify and treat life threats per **General Trauma Protocol**
5. Provide psychological support
6. Assess for signs of Crush syndrome as listed above, document entrapment time.

7. Consider the use of a tourniquet on the affected limbs if IV cannot be initiated or for rapid extrication, Per **Tourniquet Application Protocol**. Record the time of the tourniquet application.
8. Administer oxygen to patient only if respiratory distress is present.
    a. Try to give the least amount of oxygen to avoid oxidative toxins.
    b. The re-introduction of oxygen into the tissue later may cause additional reperfusion injury by creating other oxidative toxins such as free radicals and superoxides.
9. Establish large bore IV(s) and infuse one (1) to two (2) liters of crystalloid (Normal Saline or LR).
    a. Careful use of fluid bolus for patients with history of cardiac or renal dysfunction.
    b. If patient is in shock, administer1-2 liters of crystalloid.
        i. Fluid should be infused as rapidly as possible.
        ii. Assess for hemodynamic stability.
        iii. Consider warmed fluids, if possible.
        iv. Use pressure infuser device, if available.
10. Initiate cardiac monitoring as soon as feasible and assess for hyperkalemia (i.e. wide QRS or peaked T waves).
11. Initiate ETCO2 monitoring for acidosis. (ETCO2 will lower with metabolic acidosis)
12. If hyperkalemia is known or suspected, medication administration should occur prior to release of the crushed limb in a coordinated fashion with the Rescue Team Leader
13. Administer Calcium Chloride 1gram slow IVP over 2-5 minutes after extrication if hyperkalemia is suspected (T waves become peaked, if QRS widens, or if hypotension develops). If using Calcium Gluconate, give 2 grams slow IVP over 2-5 minutes
14. Ventilated patients should be hyperventilated during reperfusion.
15. Administer Albuterol 15 mg via nebulizer during extrication process.
    a. If possible, give at the same time as the Sodium Bicarbonate listed below.
    b. This promotes the movement of potassium into cells to help treat the hyperkalemia
16. Administer Sodium Bicarbonate 50 mEq IVP just prior to extrication.
    a. Consider pre-alkalinizing diuresis by adding 50 mEq of sodium bicarbonate to each liter of normal saline if extrication is prolonged for more than one hour and hyperkalemia is suspected.
17. Treat pain per the **Pain Management Protocol**.
18. Monitor when patient urinates: amount, color, and time.
19. Avoid nephrotoxic medications (NSAIDS)

20. The on-scene or on-call USAR Team Physician shall be contacted for further direction or medication administration.

Medical Management Options

- Assess patient for other injuries and treat for either hypothermia or hyperthermia depending on the exposure.
- Crush syndrome patients, once released from entrapment, are likely to exhibit agitation, severe pain, muscle dysfunction, swelling, and other systemic symptoms.
- If entrapment is endangering the patient's or rescuer's life, field amputation may be considered. Consult with the incident commander and USAR Team Physician.