LIGHTNING INJURIES

LIGHTNING INJURIES DIFFER SUBSTANTIALLY FROM HIGH-VOLTAGE ELECTRICAL INJURIES SEEN FROM HUMAN-GENERATED SOURCES

THERE ARE DIFFERENCES IN INJURY PATTERNS, INJURY SEVERITY AND EMERGENCY TREATMENT

Table 213-1 Comparison of Lightning and Electrical Injuries

Factor	Lightning	High-Voltage AC	Low-Voltage AC
Current duration	10 microseconds to 3 milliseconds.	Generally brief (1–2 s), but may be prolonged.	0.3 s or many minutes.
Typical voltage and current range	10 million to 2 billion V, 10 to 200,000 A.	600–200,000 V, <1000 A.	<600 V, usually <20–30 A.
Current characteristics	Unidirectional (DC).	Alternating (AC).	Alternating (AC).
Current pathway	Skin flashover; deeper pathways can result in burns.	Horizontal (hand to hand), vertical (hand to foot).	Horizontal (hand to hand), vertical (hand to foot).
Tissue damage	Superficial and minor if no deep tissue pathway.	Deep tissue destruction.	Sometimes deep tissue destruction.
Initial rhythm in cardiac arrest	Asystole.	Asystole more than ventricular fibrillation.	Ventricular fibrillation.
Renal involvement	Myoglobinuria is uncommon, and renal failure is rare.	Myoglobinuria and renal failure are relatively common.	Myoglobinuria and renal failure occur occasionally.
Fasciotomy and amputation	Rarely necessary.	Relatively common.	Sometimes necessary.
Blunt injury	Caused by explosive shock wave that can throw the person and cause eardrum rupture.	Caused by falls, being thrown from current source, tetanic contractions.	Caused by tetanic contraction, falls, being thrown from current source.
Immediate cause of death	Prolonged apnea, blunt injury, deep tissue burns.	Prolonged apnea, ventricular fibrillation, blunt injury, deep tissue burns.	Ventricular fibrillation, prolonged apnea, blunt injury.

PATHOPHYSIOLOGY:

- Lightning often travels OVER THE SURFACE OF THE BODY called “FLASHOVERS”
    - Less likely to cause internal cardiac injury or muscle necrosis than is human-generated electrical energy
    - Wet skin may ACTUALLY DECREASE RISK OF INTERNAL INJURY
        - ∴ people can survive lightning strikes with little or no injury
- Can cause internal injury due to blunt trauma
- Large current flow in lightning causes pulsed magnetic field than can induce current flow in a nearby person and this can produce destructive effects
- Lightning emits, BRIEF BUT INTENSE THERMAL RADIATION
    - Produces rapid heating and expansion of the surrounding air
    - Tympanic membrane perforation & internal organ contusion may occur
- Intense photic stimulation may damage the retina or produce cataracts

KERAUNOPARALYSIS:

- Refers to NERULOGIC AND MUSCULAR “STUNNING”
    - Produces variety of neurologic signs & symptoms and in some cases is associated with successful resuscitation after cardiorespiratory arrest.

- Excessive autonomic nervous system stimulation may be responsible for these transient symptoms
- More persistent and sometimes permanent sequelae can include muscular weakness and pain, photophobia and disturbance of neurologic control

TYPES OF LIGHTNING STRIKES:

- DIRECT STRIKE
    - When victim is struck directly by lightning discharge
- SIDE FLASH
    - Occurs when a nearby object is struck and current then traverses through the air to strike the victim (multiple victims possible)
- CONTACT STRIKE
    - Strikes an object the victim is holding
- GROUND CURRENT
    - When lightning hits the ground and current is transferred through the ground to nearby victims
    - The amount of voltage and current decrease as the distance between the victim and strike point increases
- STRIDE POTENTIAL
    - The foot closer to the strike point will experience a higher electrical potential than the foot further away
    - Current can enter one foot, travel up, through the torso and down the other leg and exit the other foot
        - Results in neurovascular injury to the leg

Immediate cardiac arrest from lightning strike results from DEPOLARISATION OF THE MYOCARDIUM AND SUSTAINED ASYSTOLE

Immediate respiratory arrest after lightning strike may be a result of DEPOLARISATION & PARALYSIS OF THE MEDULLARY RESPIRATORY CENTRE

- Both cardiac & respiratory arrest may be present without evidence of external injury
- Although cardiac automaticity may return spontaneously, concomitant respiratory arrest may persistent and lead to a secondary hypoxic cardiac arrest
- Duration of respiratory arrest, rather than the duration of cardiac arrest, appears to be the critical prognostic factor
- Prolonged respiratory support may be needed

CARE AT THE SCENE:

TRIAGE CONSIDERATIONS

- In contrast to patients with cardiac arrest caused by mechanical trauma, persons with lightning injury who appear to be dead (in respiratory arrest, with or without cardiac arrest) should be treated first
- They have a reasonable chance of successful resuscitation and prolonged CPR is sometimes successful

Table 213-2 Rescuer Safety in Care of a Person with Cardiac Arrest Outdoors in a Lightning Storm
Differential diagnosis (may be quickly resolved from bystander observations)
Complication of a medical condition
Stride potential from (or other contact with) a downed power line or energized support wire
Lightning strike
Safety issues for power lines on the ground:
Power lines may be difficult to see because of
Plant growth and other objects
Darkness
Similarity of line color to color of the ground
Danger signs include (presence depends on ground composition and moisture)
Auditory: sizzling or buzzing sounds
Visual: steaming or burning associated with a downed line
Olfactory: smoke or unusual odors
Power lines are *not* insulated, even though they may appear to be. Discoloration of the surface of the metal conductor is common due to exposure to the weather and air pollution.
Power line voltage is usually around 7000 V in residential areas, higher elsewhere.
See Chapter 212, Electrical Injuries, for additional power line safety considerations.

ED DIAGNOSIS AND TREATMENT:

- The usual advanced cardiac and trauma treatment principles apply.
- Lightning victims in cardiac arrest have a better prognosis than those in cardiac arrest from coronary artery disease
    - AGGRESSIVE RESUSCITATIVE EFFORTS ARE INDICATED
- HYPOTENSION IS NOT AN EXPECTED FINDING AFTER ROSC
    - Warrants investigation for haemorrhage
- Cutaneous burns may help identify and suggest potential organ injury

CARDIAC EFFECTS:

- In the victim with spontaneous circulation, HT and tachycardia are common (presumably due to sympathetic activation)
    - Specific treatment is not necessary
- Cardiac effects reported after lightning injury;
    - global depression of myocardial contractility, coronary artery spasm, pericardial effusion and atrial/ventricular arrhythmia
- ECG may show acute injury --> ST elevation, QT prolongation
    - TWI associated with neurologic injury

NEUROLOGIC INJURY:

- Many lightning-strike victims are rendered unconscious or have temporary lower extremity paralysis
- Most lethal neurologic injuries include;
    - HEAT-INDUCED COAGULATION OF THE CEREBRAL CORTEX, DEVELOPMENT OF EXTRADURAL OR SUBDURAL HAEMATOMA, AS WELL AS INTRACRANIAL HAEMORRHAGE
- Autonomic dysfunction caused by lightning may produce pupillary dilation or ANISCORIA (unequal pupils) not related to brain injury (uncertain prognostic significance)
- Transient effects, typically resolve in 24 hours (LOC, confusion, amnesia and extremity paralysis)
- Delayed and often progressive disorders
    - Seizures, muscular atrophy, amyotrophic lateral sclerosis, progressive cerebellar ataxia, myelopathy with paraplegia or quadriplegia, chronic pain syndromes
- CT scan needed in cases of coma, altered mental state or headache/ confusion

VASCULAR EFFECTS:

- VASOMOTOR SPASM
- Severe vasoconstriction is thought to be responsible for loss of pulses, mottling of skin and coolness of extremities
- Paralysis may be due to ischaemia to peripheral nerves
- As vasoconstriction resolves spontaneously, these signs and symptoms often resolve
- Because skeletal muscle injury is rare in lightning strike, COMPARTMENT SYNDROMES ARE USUALLY NOT A CONSIDERATION

OCULAR INJURY:

- Ophthalmic injuries are common in lightning-strike victims
    - CATARACT MOST FREQUENTLY, usually bilateral and may form months to years down the line
- Lightning can affect any part of the eye and thus a patient with discomfort or visual changes deserves a careful examination with follow up.

AUDITORY INJURY:

- Blast effect can cause TM rupture
- Victims sustaining lightning strike via a conventional corded telephone are at higher risk for otologic injury

MUSCULOSKELETAL INJURY:

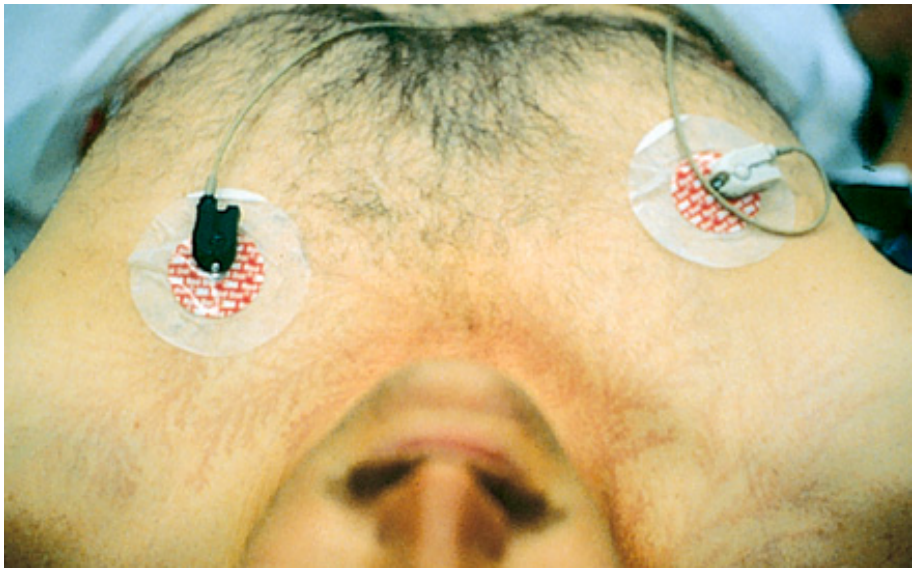
- Variety of skeletal fractures can be seen from blunt force injury
- Intense myotonic contractions can produce shoulder dislocations as well as spinal fractures.
- Rhabdomyolysis after lightning strike is unusual

CUTANEOUS INJURY:

- There are six main dermatologic manifestations of lightning injury
    - LICHTENEBERG FIGURES
        - Superficial ferning or feathering pattern.
        - Considered pathognomonic
    - Flash burns --> similar to arc welders
    - PUNCTATE BURNS --> similar to cigarette burns
    - Contact burns, superificial erythema and blistering can all occur
- Standard burn treatment applies

Punctate burns

Lichtenberg figures seen on upper chest



DISPOSITION & FOLLOW-UP.

- Thorough careful evaluation for the above injuries.
- ECG is mandatory.
- Admission for:
    - Persistent neurological injury
    - Cardiac dysrhythmia
    - Vascular abnormalities.

SPECIAL POPULATIONS:

- Foetal injury & death have been noted to follow lightning strike with little or nor maternal injury
    - CTG monitoring for at least 4 hours advised