Objectives
• Explore the complex mechanism of blast trauma
• Discuss factors that affect survival
• Learn some of the common injuries seen in blast trauma

Why are blast injuries unique?
• Complex: blunt and penetrating
• Even more complex.. Burns, micro vascular, and inflammation
• Physics of the blast wave itself is complex: over pressurization, expanding positive pressure followed by negative pressure, reverberations/reflections
• Many factors affect severity
• Historically limited opportunities to learn

Factors affecting the severity of Injury
• Device
• Environment
• Proximity
• Barriers
• In trauma response: Time, time, time, care

Environment
• Closed places, such as a bus or subway train, or a small room or elevator, are worse than larger open areas
• In blast event in open air in Israel mortality among casualties 8% (15/204 injured) as compared to similar device in bus resulting in mortality rate of 49%, 46 / 93 injured
• ISS for patients in confined spaced was also higher

Proximity and Outcome in Blast Trauma

Mechanisms of Blast Injury

Primary: Impact of the blast wave
Secondary: Flying debris
Tertiary: Blunt trauma (blast wind)
Quaternary: Burns, Crush, TBI etc.
Quinary: Psychological

Layers of Injury

• Primary injury
  • Overpressurization (Blast) wave
• Secondary injury
  • Penetrating trauma: debris, shrapnel, nuts, bolts
  • Tertiary injury
    • Blunt force: striking walls/ground
• Quaternary injury
  • Burns, poisoning

Blast Injuries: Primary

• Supersonic overpressure shock wave -> ahead of the shards/shrapnel and blast wind
• IED: HE type
• Pathophysiology: Barotrauma
• Most common injuries: Pulmonary barotrauma, TM rupture, globe rupture, bowel hemorrhage or organ perforation

Blast Injuries: Secondary

• Secondary blast injuries: MC cause of death
• Flying debris: from bomb housing, from inside bomb and picked up from around bomb
• Intentional, IED: HE and LE
• Small wound/ mild skin findings or puncture -> deep debris (imaging)
• Contaminated

Blast Injuries: Tertiary

• Blast wind -> severity depends on speed of wind
• Most commonly blunt (penetrating can occur!)
• Head trauma, fractures, solid organ trauma
Blast Injuries: Quaternary

- All injuries not associated with primary, secondary, or tertiary mechanism
- Burns, Crush, Radiation, TBI, Toxins, and worsening of preexisting medical problems
- Long term injuries: Inflammation and reactive mechanism
- Diagnosis can be delayed

14 Year Old, M80 explosion

Blast Injuries: Head

- Primary blast waves -> concussions or mild traumatic brain injury (MTBI) without a direct blow to the head, TM rupture
- Eardrum injury
- Fracture
- Bleeding
- TBI

Blast Injuries: TM Rupture

17 Year Old M, Home-made firecracker

- Blast wave: high elastic recoil of lung -> hemorrhage
- Contusions, fractures
- Toxic inhalation, burns, pulmonary edema
- “Pink frothy” hemoptysis
- Hypoxia

Blast Injuries: Abdomen

- Blast wave: hollow organ injury
- Blunt trauma
- Debris
- Other: burns, crush injury, inflammation
34 Year Old F, Lawn mower spont. explosion

15 Year Old M, Home-made explosion (PB)

Combined Injuries

- Combined injuries are common
- Consider injuries from the primary blast wave (due to pressure) in combination with penetrating trauma (from debris/bomb) and blunt trauma (wind)
- Delayed injuries are gaining understanding: TBI, and role of inflammation
- Injuries often complicated by burns and infection

Key Points

- Blast trauma has mechanism of injury characterized by the over-pressurization (blast) wave, penetrating debris, blast wind, and immediate and long term affects of the injury
- Device, environment, proximity and barriers play a key role in the severity of blast trauma and affect survival
- Common injuries include to the eyes and ears, head, lungs, and abdomen

Thank You

Questions and Comments