Chapter 38

Bleeding and Soft Tissue Trauma

Learning Objectives

• Describe the normal structure and function of the skin.
• Describe the pathophysiological responses to soft tissue injury.
• Discuss pathophysiology as a basis for key signs and symptoms, and describe the mechanism of injury and signs and symptoms of specific soft tissue injuries.
Learning Objectives

• Outline management principles for prehospital care of soft tissue injuries.
• Describe, in the correct sequence, patient management techniques for control of hemorrhage.
• Identify the characteristics of general categories of dressings and bandages.

Learning Objectives

• Describe prehospital management of specific soft tissue injuries not requiring closure.
• Discuss factors that increase the potential for wound infection.
• Describe the prehospital management of selected soft tissue injuries.

Hemorrhage

• Hemorrhage
  – Occurs when disruption, or “leak,” occurs in vascular system
  – Sources can be external or internal
External Hemorrhage

• Results from soft tissue injury
• Accounts for about 2.3 million emergency department visits in U.S. each year
• Most soft tissue trauma is accompanied by mild hemorrhage
  — Usually does not pose threat to life
  — Can carry major risks of morbidity and disfigurement

External Hemorrhage

• Seriousness of injury depends on three factors
  — Anatomical source of hemorrhage
    • Arterial
    • Venous
    • Capillary
  — Degree of vascular disruption
  — Amount of blood loss patient can tolerate

Internal Hemorrhage

• Can result from
  — Blunt or penetrating trauma
  — Acute or chronic illnesses
• Insufficient amount of circulating blood can occur in
  — Chest
  — Abdomen
  — Pelvis
  — Retroperitoneum
Internal Hemorrhage
• Intracranial hemorrhage can cause grave hemodynamic instability from loss of blood
  – Associated with higher morbidity and mortality rates than external hemorrhage

Internal Hemorrhage
• Signs and symptoms
  – Bright red blood from mouth, rectum, or other orifice
  – Coffee-ground appearance of vomitus
  – Melena (black, tarry stools)
  – Hematochezia (passage of red blood through rectum)
  – Dizziness or syncope on sitting or standing
  – Orthostatic hypotension

Why do you think internal hemorrhage is associated with an increase in morbidity and mortality rates?
Skin Anatomy and Physiology

• Skin
  – Tough, supple membrane that covers entire body
  – Largest and most dynamic organ of body
  – Covers more than 20 sq. ft., makes up 16 percent of total body weight
  – Two distinct layers of tissue
    • Outer layer (epidermis)
    • Inner layer (dermis)

Epidermis

• Thin, nonvascular epithelial tissue
  – Derives nourishment from capillaries of dermis
  – Epidermis composed of five layers
    • Stratum basale
    • Innermost layer; stratum spinosum
    • Stratum granulosum
    • Stratum lucidum
    • Stratum corneum, most superficial layer, composed of about 20 layers of dead skin cells that are filled with waterproofing protein keratin
Dermis

• Lies beneath epidermis
  – Protects against bacterial invasion
  – Helps maintain fluid balance
• Contains
  – Connective tissue
  – Elastic fibers
  – Blood vessels
  – Lymph vessels
  – Motor and sensory fibers

Dermis

• Houses other structures of integumentary system
  – Hair
  – Nails
  – Sebaceous and sweat glands
• Connective tissue and elastic fibers in dermis give skin its strength and elasticity
  – Blood vessels in dermis nourish all skin cells
    • Aid in body temperature regulation through vasoconstriction or vasodilation

Dermis

• Nerves in dermis
  – Generate impulses to dermal muscles and glands
  – Carry impulses away from sensory receptors in skin in response to pain, touch, heat, cold
• Dermis has reservoir of defensive and regenerative elements
  – Combat infection
  – Repair deep wounds
    • Use of specialized white blood cells, lymphatics, other cellular components
Predict the effects of destruction of a large segment of skin, including the dermis, based on your knowledge of its functions.

Dermis

- Deep fascia
  - Dense layer of fibrous tissue beneath dermis
  - Provides for
    - Insulation
    - Cushioning
    - Caloric reserve
    - Body substance and shape
  - Primary function: support and protect underlying structures

Pathophysiology

- Surface trauma
  - Can disrupt normal distribution of body fluids and electrolytes
  - Can interfere with maintenance of body temperature
  - Two physiological responses to surface trauma are vascular and inflammatory reactions
    - Can lead to healing, scar formation, both
    - Extent and success of these responses influenced by amount of tissue disrupted
Hemostasis of Wound Healing

• Initial physiological response to wounding
  – Vascular reaction involves
    • Vasoconstriction
    • Formation of platelet plug
    • Coagulation
    • Growth of fibrous tissue into blood clot that permanently closes and seals injured vessel

Hemostasis of Wound Healing

• Vasoconstriction resulting from injury is rapid but temporary
  – In response to injury, severed blood vessels constrict and retract with aid of surrounding subcutaneous tissues
  – Vessel spasm slows blood loss immediately and may completely close ends of injured vessels
  – Usually sustained for as long as 10 minutes
    • During this time, blood coagulation mechanisms are activated to produce blood clot

Hemostasis of Wound Healing

• Platelets adhere to injured blood vessels and to collagen in connective tissue that surrounds injured vessel
  – As platelets contact collagen
    • They swell
    • Become sticky
    • Secrete chemicals that activate other surrounding platelets
  – Process creates a platelet plug in injured vessel
  – If opening in vessel wall is small, plug may be sufficient to completely stop blood loss
  – For larger wounds, blood clot is necessary to stop flow of blood
Hemostasis of Wound Healing

• Blood coagulation
  – Occurs as result of chemical process that begins
    • Within seconds of severe vessel injury
    • Within 1 to 2 minutes of a minor wound
  – Progresses rapidly
    • Within 3 to 6 minutes after rupture of vessel, entire end of the vessel is filled with clot
    • Within 30 minutes, clot retracts and vessel is sealed further

Hemostasis of Wound Healing

• Clotting cascade includes following three mechanisms
  – Prothrombin activator is formed in response to rupture or damage of blood vessel
  – Prothrombin activator stimulates conversion of prothrombin to thrombin
  – Thrombin acts as enzyme to convert fibrinogen into fibrin threads
    • Threads entrap platelets, blood cells, plasma to form clot
Hemostasis of Wound Healing

• Process of hemostasis usually is protective and required for survival
  – Can result in responses that threaten life and function
  – Examples include blood clots that form in atherosclerotic vessels that lead to MI or stroke

List some drugs that may impair the normal clotting functions.

Inflammatory Response

• Release of chemicals from injured vessel and various blood components (platelets, white blood cells) causes localized vasodilation of
  – Arterioles
  – Precapillary sphincters
  – Venules
• Response increases permeability of affected capillaries and vessels
Inflammatory Response

- The following accumulate in extracellular space for about 72 hours after the injury
  - Plasma
  - Plasma proteins
  - Electrolytes
  - Chemical substances from leaking venules
    - Blood flow increases to area of injury to supply metabolic demands of tissues during healing
    - Results in redness, swelling, and pain associated with inflammation

Inflammatory Response

- The transportation of granulocytes, lymphocytes, and macrophages to injured area also increases local blood flow
  - Specialized cells prepare wound for healing
    - Clear foreign bodies and dead tissue
    - Trigger new vessel formation
    - Within 12 hours of injury, new epithelial cells are regenerated (epithelialization phase)
    - Cells begin process of healing through reestablishment of skin layers

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Inflammatory Response

• Collagen
  – Main structural protein of most body tissues
  – Normal repair of tissues depends on collagen synthesis and deposition
  – In healthy body, fibroblasts synthesize and deposit collagen within 48 hours after injury
  – Collagen increases tensile strength of tissue
  – Most injured tissue will not regain its full strength and function until at least 4 months later

Alterations of Wound Healing

• Factors that can affect or alter wound healing
  – Anatomic factors
  – Concurrent drug use
  – Medical condition and disease
  – Wounds that are high-risk

Anatomic Factors

• Some tissues of body heal better and faster than others because of
  – Body region
  – Amount of tension on tissues (lines of tension)
    • Elasticity of skin and lines of tension vary in different areas of body
    • Affected by muscular contraction and body movements of flexion and extension
Anatomic Factors

- Factors that affect wound healing and scar formation
  - Soft tissue injury to forearm generally heals better and faster than one over joint
  - Other anatomical factors that may adversely affect wound healing and scar formation include oily skin and pigmentation

Concurrent Drug Use, Existing Medical Conditions, and Disease

- Certain factors can delay or interfere with normal wound-healing process through various mechanisms
  - Patient’s concurrent drug use
  - Existing medical conditions
  - Disease

- Common drugs that can alter wound healing
  - Corticosteroids
  - Nonsteroidal anti-inflammatory drugs (aspirin)
  - Penicillin
  - Colchicine
  - Anticoagulants
  - Antineoplastic agents
Concurrent Drug Use, Existing Medical Conditions, and Disease

- Medical conditions and diseases that can delay healing
  - Advanced age
  - Severe alcoholism
  - Acute uremia
  - Diabetes
  - Hypoxia
  - Peripheral vascular disease
  - Malnutrition
  - Advanced cancer
  - Hepatic failure
  - Cardiovascular disease

High-Risk Wounds

- Have an increased potential for infection, depending on
  - Location of wound
  - Nature of wounding force
- Wound forces associated with high risk for infection
  - Produced by human and animal bites
  - Foreign bodies
  - Injection (e.g., high-pressure grease guns)

High-Risk Wounds

- Other high-risk wounds
  - Those contaminated with organic material or that have significant amount of dead (devitalized) tissue
  - Crush wounds
  - Wounds in immunocompromised patients or who have poor peripheral circulation
Abnormal Scar Formation

- Can result in keloid or hypertrophic scar
  - Keloid is excessive accumulation of scar tissue that extends beyond original wound borders
  - Abnormal scar is more common in darkly pigmented patients
  - More common in those who have injuries to ears, upper extremities, lower abdomen, or sternum
  - Hypertrophic scar has excess accumulation of scar tissue within original wound borders
  - More common in areas of high tissue stress such as flexion creases across joints

Wounds Requiring Closure

- Expect the following types of wounds to require closure
  - Wounds to cosmetic regions (e.g., face, lips, and eyebrows)
  - Gaping wounds
  - Wounds over tension areas (e.g., joints)
  - Degloving injuries (described later in this chapter)
  - Ring finger injuries
  - Skin tearing

- Many techniques are used to close wound
  - Suture
  - Tape
  - Staples
  - Tissue adhesives
Pathophysiology and Assessment of Soft Tissue Injuries

- Soft tissue injuries are classified as closed or open
  - Classification depends on absence or presence of break in continuity of epidermis
  - Soft tissue wounds often are most evident injury
    - Generally considered low-priority injuries unless life-threatening hemorrhage or associated airway compromise is present

Closed Wounds

- Usually associated with little blood loss
  - Some can cause significant hemorrhage in cavities of
    - Thorax
    - Abdomen
    - Pelvis
    - Soft tissues of legs
- Classifications
  - Contusion
  - Hematoma
  - Crush injury

Contusions and Hematomata

- Blunt trauma causes contusions and hematomata
- Contusion
  - Characterized by blood vessel disruption beneath epidermis
  - Results in swelling, pain, ecchymosis (bruising) that can occur 24 to 48 hours after injury
Contusions and Hematomata

- Hematoma
  - Collection of blood beneath skin
  - May occur with contusion
  - Represents larger amount of tissue damage and disruption of larger vessels
  - Wounds usually superficial
  - Sometimes associated with
    - Underlying fractures
    - Vascular involvement
    - Significant hemorrhage

Crush Injury

- Can occur when crushing force is applied to body area
  - Can be severe
- Associated with
  - Internal organ rupture
  - Major fractures
  - Hemorrhagic shock
- Overlying skin may remain intact with crush injury, even in presence of severe injury and shock
What are some mechanisms of crush injury?

Open Wounds

- Classifications
  - Abrasion
  - Laceration
  - Puncture
  - Avulsion
  - Amputation
  - Bites
**Abrasion**

- Partial-thickness skin injury
  - Caused by scraping or rubbing away of layer or layers of skin
  - Usually results from friction with hard object or surface
  - Although these wounds often are superficial, are painful and at high risk for infection from contamination

**Laceration**

- Results from tear, split, or incision of skin
  - Most often caused by knife or other sharp object
    - Results in linear wound or incision
  - Sizes and depths of lacerations vary greatly depending on injury sites and wounding mechanism
  - Can be sources of significant bleeding
Puncture

- Contact with sharp, pointed object commonly causes puncture wound
  - Entrance wound generally is small
  - May be associated with deep penetration and injury to underlying tissues
  - Can be difficult to assess in prehospital setting
  - Even injury that appears minor can conceal considerable internal damage
Puncture

- In some penetrating injuries, object remains embedded or impaled in wound
  - If chest or abdomen is involved, severe bleeding and major underlying damage to internal organs can occur
- Examples
  - Chest injury
  - Pneumothorax (simple, open, tension)
  - Hemothorax
  - Pericardial tamponade
  - Penetrating heart wound
  - Rupture of esophagus, aorta, diaphragm, main stem bronchus
  - Abdominal injury
  - Hollow and solid organ damage
  - Peritonitis (bacterial, chemical)
  - Evisceration

Why should a person always seek medical care to have a penetrating object removed?
Puncture

• Injection of substance into body under high pressure also can cause puncture wound
  – Often have life-or limb-threatening potential
  – Often require rapid surgical decompression and debridement

Puncture

• Usually associated with minimal bleeding
  – May not appear serious
  – Numbness and blanching of involved area often occur because of increased tissue pressure of injected substance
  – Most are surgical emergencies
Puncture

• High risk for developing compartment syndrome
• Definitive care for injection injuries usually requires surgery and hospitalization to prevent infection
  – Amputation may be needed if treatment is delayed

Avulsion

• Full-thickness skin loss
  – Wound edges cannot be approximated
  – Frequently involved body areas
    • Ear lobes
    • Nose tip
    • Fingertips
• Common causes
  – Industrial equipment, such as meat slicers or sawing devices
  – Domestic violence, such as human bites
Avulsion

- Degloving injury is type of avulsion
  - In this injury, shearing forces separate skin from underlying tissues
  - Common causes
    - Industrial machinery may entangle extremity, producing circumferential tearing
    - Finger jewelry that gets caught on a stationary object

Avulsion

- Can produce shearing of soft tissue and possibly of bone of digit
  - Another common cause is machinery that entraps hair, resulting in scalp avulsion.
- Degloving injuries
  - Sometimes associated with underlying skeletal damage
  - Sometimes associated with massive loss of tissue in affected area
  - Bleeding can be significant
Amputation

- Involves complete or partial loss of limb by mechanical force
  - Digits, lower leg, hand and forearm, and distal part of foot most often injured this way
  - Bleeding is possible fatal complication of amputation injury
    - When complete amputation has occurred, injured arteries often retract
    - Hemorrhage may be less severe than in partial amputation injuries

Bites

- An animal or human bite wound frequently is combination of
  - Puncture
  - Laceration
  - Avulsion
  - Crush injury
- Pressure from bite can be as great as 400 psi
- Bite can involve deep structures such as tendons, muscles, and bones
Bites

• Complications from bite wounds, particularly human bites
  – Abscesses
  – Lymphangitis
  – Cellulitis
  – Osteomyelitis
  – Tenosynovitis
  – Tuberculosis
  – Hepatitis B
  – Tetanus

• Other less common complications of mammalian bites include transmission of diseases
  – Actinomycosis
  – Syphilis
  – Rarely, rabies
• All patients who have been bitten should seek physician evaluation
Aside from caring for the patient’s wounds and documenting that care, what other concerns and responsibilities do you have when caring for someone who has sustained an animal bite?

Crush Injury

- One of three injuries that occurs when tissue is exposed to compressive force
  - Force can be sufficient to interfere with normal structure and metabolic function of involved cells and tissues
  - Degree of injury produced by crushing force depends on
    - Amount of pressure applied to body
    - Amount of time pressure remains in contact with body
    - Specific body region in which injury occurs
  - Massive crush injury to vital organs can cause immediate death

Crush Injury

- Usually involves upper or lower extremities, torso, or pelvis
- Can result from entrapment under a heavy object, as in foundation collapse, or from some other massive compressive force
Crush Injury

- Examples
  - Collapse of masonry or steel structures
  - Collapse of earth (e.g., mud slides and earthquakes)
  - Motor vehicle crashes
  - Warfare injuries
  - Industrial incidents
  - Prolonged application of a pneumatic antishock garment and improperly applied casts

Compartment Syndrome

- Result of crush injury
- Surgical emergency
  - Results from compressive forces or blunt trauma to muscle groups confined in tight fibrous sheaths with minimal ability to stretch
    - Below knee
    - Above elbow

Compartment Syndrome

- Less common causes
  - Extreme exertional exercise
  - Low-level repetitive injury
  - Electrical injury
  - Hemorrhage into compartment (e.g., coagulopathy among hemophiliacs)
  - Circumferential deep burns and electrical burns
  - Vascular occlusion
  - High-pressure injection injuries
  - Immobility with development of pressure necrosis (e.g., among alcoholics, drug addicts, and victims of stroke)
Why would alcoholics, drug addicts, and stroke victims be at risk for compartment syndrome?

Compartment Syndrome

• Develops as associated hemorrhage and edema increase pressure in closed fascial space (compartment)
  – Results in ischemia to muscle
  • Causes further muscle cell swelling
  • Intracompartmental pressure continues to rise
  • Circulation is compromised
  • Irreversible tissue damage from lack of O₂ develops within several hours to several days after injury
Compartment Syndrome

• In addition to muscular damage, any nerves that travel through compartment can undergo necrosis if condition remains untreated
• Signs and symptoms in extremity include those of vascular insufficiency
  – 5 Ps

Compartment Syndrome

• Other signs and symptoms
  – Pain seemingly out of proportion to injury
  – Swelling (tautness of compartment)
  – Tenderness to palpation
  – Weakness of involved muscle groups
  – Pain on passive stretch (earliest finding)

Compartment Syndrome

• Recognition calls for high degree of suspicion based on patient history and mechanism of injury
  – Most often associated with tibial fracture of lower leg
  – Can occur with crush injury or fracture of femur, forearm, or upper arm
  – Delayed treatment can result in
    • Nerve death
    • Muscle necrosis
    • Crush syndrome
Crush Syndrome

- Life-threatening and sometimes preventable complication of prolonged immobilization or compression
- Syndrome is pathological process that causes destruction or alteration of muscle tissue

Crush Syndrome

- Rare and most likely to occur in catastrophic events in which patient rescue and extrication are delayed beyond 4 to 6 hours
- Prehospital management often determines patient outcome

Crush Syndrome

- Compressive forces of entrapment believed to produce crush syndrome
  - Pathological process disrupts vascular integrity
  - Causes loss of structure of cell and cell membranes
  - May appear stable for hours or days, as long as compressive forces remain in place
Crush Syndrome

• When patient is released from entrapment, three harmful processes occur at the same time that can lead to death
  – Oxygen-rich blood returns to ischemic extremity
    • Produces pooling of intravascular volume into crushed tissue
    • Reperfusion reduces total circulating volume, which in turn often leads to shock

Crush Syndrome

• Harmful processes
  – With return of oxygen-rich blood, various toxic substances and waste products of anaerobic metabolism are released into systemic circulation
    • Causes metabolic acidosis
    • High levels of intracellular solutes and water are released from damaged cells
    • Results in hyperkalemia, hyperuricemia, hypocalcemia, hyperphosphatemia
  – Myoglobin is released from damaged muscle cells of injured extremity

Blast Injuries

• Severe injuries can result from
  – Initial air blast
  – Flying debris
  – Secondary contact with another object as victim is thrown by the blast
• Examples
  – Natural gas or gasoline explosions
  – Fireworks explosions
  – Explosions in grain elevators
  – Terrorist bombs
Blast Injuries

• Scene and personal safety is of highest priority
  – Do not enter scene where blast injury occurred until scene has been made safe by authorities
    • Law enforcement
    • Fire service
    • Specialized rescue teams
    • Hazardous materials teams
    • Other public service agencies

Blast Injuries

• Injuries can be superficial or deep
  – Deep injuries can injure internal organs
• Treatment
  – Rapid stabilization
    • Airway and ventilatory support with spinal precautions
    • Circulatory support
  – Rapid transportation
Blast Injuries

- Associated trauma can be difficult to identify in prehospital setting
  - Patients will need extensive evaluation in trauma center
- Compression injuries that occur to air-filled organs include
  - Rupture of eardrum, sinuses, lungs, stomach, intestines

What injury do you suspect if a patient who has suffered a blast injury has a sudden onset of hearing loss?

Management Principles for Soft Tissue Injuries

- Personal and scene safety is always priority in any emergency response
  - If indicated, law enforcement and rescue personnel should advise EMS crew that scene is relatively safe to enter and that any perpetrators have been apprehended
  - Even so, always be alert for possible hazards at scene
  - Help from other public service agencies also be needed if other dangers exist
  - Examples: hazardous materials or bombs
Treatment Priorities

• Assessment of life-threatening injuries and resuscitation precedes evaluation and intervention of non-life-threatening soft tissue injuries
  – Evaluate wounds that do not pose threat to life later in physical exam
  – General wound assessment should include history of wounding event and careful examination of injury

Wound History

• Wound history should include
  – Time of injury
  – Environment where injury occurred (risk of infection is greater in unclean environments)
  – Mechanism of injury and likelihood of concurrent or associated injuries
  – Volume of blood loss
  – Severity of pain
  – Medical history, including use of medications that may impair hemostasis
  – Tetanus immunization
Physical Examination

• Physical examination of wound
  – Inspect for
    • Bleeding
    • Size
    • Depth
    • Presence of foreign bodies
    • Amount of tissue lost
    • Edema
    • Deformity

Physical Examination

• Physical examination of wound
  – Inspect area surrounding wound for damage to
    • Underlying structures
    • Arteries
    • Nerves
    • Tendons
    • Muscle

Physical Examination

• Physical examination of wound
  – Assessment of sensory or motor function of extremity
  – Evaluation of perfusion status of wound and tissue distal to wound
  – Palpation of injury and associated structures to evaluate
    • Capillary refill
    • Distal pulses
    • Tenderness
    • Temperature
    • Edema
    • Crepitus (if underlying bony injury is suspected)
Will you perform this physical examination on every wound in the prehospital setting?

Hemorrhage and Control of Bleeding

- Blood loss often is associated with soft tissue injury
  - May result from damage to arteries, veins, capillaries, or combination
  - Arterial bleeding is characterized as bright red and spurting
  - Venous bleeding is dark reddish-blue and flowing
  - Capillary bleeding is bright red and oozing
  - Differentiation among types of vessel hemorrhage often is difficult
  - In prehospital setting, main concern in hemorrhage is to control bleeding

Hemorrhage and Control of Bleeding

- Methods of hemorrhage control
  - Direct pressure
  - Immobilization by splinting
  - Pneumatic pressure devices (air splints, pneumatic antishock garment)
  - Use of tourniquets
Hemorrhage and Control of Bleeding

• Methods of hemorrhage control
  – Must take personal protective measures
  – Use of pressure on artery proximal to wound and elevation of extremity to control hemorrhage are no longer recommended as part of prehospital care
    • Insufficient data to support its effectiveness

Direct Pressure

• Control external hemorrhage by applying direct pressure over injury site
  – Direct pressure controls most types of hemorrhage within 4 to 6 minutes
  – To maintain control, pressure dressing can be applied over site and held in place with elastic bandage
    • Must continue direct pressure, even with a pressure dressing
Direct Pressure

- Once dressing is applied, do not remove
  - Can disrupt the fresh blood clot
  - If bleeding resumes and dressing becomes soaked with blood, second dressing should be applied on top of first one and held in place with direct pressure until bleeding is controlled

Why should the pressure point chosen to control hemorrhage be proximal to the injury?
Immobilization by Splinting

- Patient movement promotes flow of blood
  - Movement can disrupt clot or increase vascular injury
  - Patients should be immobilized whenever possible
    - Can immobilize extremity injuries with appropriate splinting devices
    - Can be immobilized fully with long spine board
    - Immobilization is not effective alone as method to control bleeding
    - Should be used as an adjunct

Pneumatic Pressure Devices

- Pneumatic pressure devices can provide uniform direct pressure to immobilized injury site
  - Devices should be applied over dressed wound only after other methods have controlled bleeding
Tourniquet

- Use of tourniquet to control bleeding was once considered “last resort” in bleeding control
  - Recent studies based on wartime injuries in Iraq and Afghanistan have proven tourniquets to be safe and effective when properly applied
Tourniquet

• Application guidelines
  – Consult with medical direction
  – Select site for tourniquet
    • Site should be about 2 inches proximal to wound and over supplying brachial or femoral artery
    • BP cuff applied over brachial artery also can act as tourniquet
    • If BP cuff is used, note time of application on cuff itself

Tourniquet

• Application guidelines
  – Place commercial tourniquet (e.g., Combat Application Tourniquet [C-A-T], Emergency Military Tourniquet [EMT], Special Operations Force Tactical Tourniquet [SOFTT]) or 4-inch wide, flat material just above wound and over artery to be compressed
    • Never use thin material such as rope or twine because it may damage underlying tissue
    • If BP cuff is used as tourniquet, inflate cuff until cuff pressure exceeds arterial pressure or to point at which hemorrhage stops

Tourniquet

• Application guidelines
  – Place pad (roll of gauze or thick folded dressings) over artery to be compressed
  – Encircle tourniquet twice around extremity and pad, and tie it in half knot over pad
  – Place windlass (stick, pen, or similar object) on half knot, and secure it in place with square knot
Tourniquet

• Application guidelines
  – Tighten windlass by twisting only until hemorrhage stops
  – Secure windlass in that position
  – Never loosen tourniquet once tightened
  – Note time of tourniquet application and secure it to patient
  – Clearly mark “TK” on patient’s forehead
  – Document tourniquet procedure on patient care report

Dressing Materials Used with Soft Tissue Trauma

• Dressing categories
  – Sterile dressings processed to eliminate bacteria
    • Should be used whenever infection of wound is concern
  – Nonsterile dressings are not sterilized
    • Can be used when infection is not prime concern
Dressing Materials Used with Soft Tissue Trauma

• Dressing categories:
  – Occlusive dressings do not allow passage of air through material
    • Useful in treating wounds of thorax and major vessels where negative pressure can cause air to enter body
    • Result in pneumothorax or air embolism, respectively
  – Nonocclusive dressings allow air to pass through material and are indicated for managing most soft tissue injuries

Dressing Materials Used with Soft Tissue Trauma

• Dressing categories
  – Adherent dressings attach to wound surface by incorporating wound exudate into dressing mesh
    • Use of these dressings sometimes can assist in controlling acute bleeding
  – Nonadherent dressings allow passage of wound exudate and do not adhere to wound surface
    • Dressings do not damage wound when removed and often are used after wound closure

Dressing Materials Used with Soft Tissue Trauma

• Bandages hold dressings in place
  – Classifications
    • Absorbent
    • Nonabsorbent
    • Adherent
    • Nonadherent
  – Sterile or nonsterile
Complications of Improperly Applied Dressings and Bandages

• Improperly applied dressings and bandages can harm patient and cause discomfort
  – Dressings applied too loosely often do not stop bleeding
  – Bandages applied too tightly can cause tissue ischemia and structural damage to vessels, nerves, tendons, muscles, skin

Basic Concepts of Open Wound Dressing

• Assess wound for
  – Size
  – Depth
  – Location
  – Contamination

• Properly prepare wound for dressing
  – Prehospital care usually limited to cleaning injured surface of gross contaminants by irrigation of wound with sterile water or normal saline
  – Do not attempt extensive debridement in prehospital setting
  – Apply antibacterial ointment if patient is not allergic (per protocol)
Basic Concepts of Open Wound Dressing

- Apply appropriate dressing
- Secure dressing in place with bandages or gauze wrappings
- Tape loose ends of bandage

Management of Specific Soft Tissue Injuries Not Requiring Closure

- Paramedic will encounter many minor open wounds that do not require closure or evaluation by physician
  - In these cases, basic first aid and instructions for self-care should be provided to patient

Dressings and Bandages

- Depending on nature and location of patient’s injury, dressings, bandages, and immobilization may be indicated to care for wound properly
- Requirements of patients with soft tissue injuries that pose a threat to life or limb
  - Rapid assessment
  - Stabilization
  - Rapid transportation
Dressings and Bandages

- Open wounds that usually require physician evaluation
  - Neural, muscular, or vascular compromise
  - Tendon or ligament compromise
  - Heavy contamination
  - Cosmetic complications (e.g., facial trauma)
  - Foreign bodies
  - Animal bites with deep punctures

Evaluation

- Local protocol may permit paramedic to manage and release patient with minor soft tissue injury to patient’s own care
  - May allow paramedic to manage and refer patient to patient’s private physician for follow-up care
  - Some EMS systems allow paramedics to provide tetanus vaccine
  - May be permitted to give written and verbal instructions regarding care to patients who will not be transported by ambulance for physician evaluation
Tetanus Vaccine

• Serious and at times fatal disease
  – Disease of CNS caused by infection of wound with spores of bacterium Clostridium tetani
  – Patient can be protected against tetanus by periodic immunization with tetanus vaccine
  – About half million cases of tetanus occur across world each year

Tetanus Vaccine

• In U.S., only about 50 or fewer cases are reported each year
  – All cases occur in non-immunized persons
  – Tetanus infection occurs mostly in those over 50 years of age
  – Deaths most likely to occur in people over 60 years of age and in diabetics

Tetanus Vaccine

• Children and adults in U.S. routinely receive combined immunization against diphtheria, tetanus, and pertussis (whooping cough)
  – Acellular pertussis [TDaP] is given to those over 7 years of age
  – Whole-cell pertussis [DTaP] is given to infants and toddlers
  – After initial immunization during childhood, children receive booster vaccines every 5 to 10 years
Tetanus Vaccine

- Patients who have not been immunized before against tetanus receive tetanus immune globulin because it confers instant immunity
  - During wound care, ascertain patient's last tetanus immunization
  - Determine any prior allergic reactions to tetanus preparations

Tetanus Vaccine

- Normal side effects
  - Slight fever
  - Sore injection site
  - Minor rash
- Contraindicated in
  - Infants less than 6 weeks of age
  - Pregnant patients
  - Those hypersensitive to vaccine

Why is it crucial for you to be knowledgeable about and to ask the patient about tetanus vaccination if the vaccine is not carried on your ambulance?
Patient Instructions

- Verbal and written instructions sometimes referred to as “patient instruction sheet”
  - Relate to wound care
  - Give instructions to all patients who are not transported for physician evaluation

Patient Instructions

- Instructions should include
  - Protection and care of wounded area
  - Dressing change and follow-up
  - Wound cleansing recommendations
  - Signs of wound infection
Wound Infection

- Infection is common complication of soft tissue injury
  - Results from break in continuity of skin and subsequent exposure to nonsterile external environment
  - Most infections are minor
    - Some can be serious
  - Goals of wound care
    - Prevent infection
    - Protect from infection

Wound Infection

- Factors that influence likelihood of infection
  - Unclean wounds
  - Wound mechanisms
  - Patient’s poor state of health
  - Factors can have both local and systemic complications and can affect patient’s general recovery

Causes of Wound Infection

- Time
  - Risk of infection can be reduced greatly if wound is cleaned and repaired within 8 to 12 hours after injury
  - Bacterial proliferation to level that can result in infection can occur as early as 3 hours after injury
- Mechanism
  - Lacerations caused by fine cutting forces resist infection better than crush injuries
  - High-velocity missile injuries can produce internal damage that may not be apparent for several days
### Causes of Wound Infection

- **Location**
  - Injuries of foot, lower extremity, hand, perineum have higher-than-normal risk for infection

- **Severity**
  - More tissue damage produced by injury, higher risk for infection

#### Causes of Wound Infection

- **Contamination**
  - Presence of foreign matter in wound decreases resistance to infection
  - Of particular concern are wounds contaminated by soil, saliva, feces

- **Preparation**
  - Body, facial, head hair removed by clipping versus shaving is less likely to result in wound infection
  - Shaving can cause additional injury by abrading skin and potentially moving skin flora into larger wound

- **Cleansing**
  - Wound cleansing should be performed with normal saline and high-pressure syringe

- ** Technique of repair**
  - Wounds at high risk for infection (e.g., animal bites) may need to be cleaned, debrided, left open for 4 to 5 days, and then closed through traditional techniques
Causes of Wound Infection

• General patient condition
  – Elderly patients and patients with concurrent illness or preexisting disease (e.g., diabetes) often are less able to ward off infection

Wound Healing Assessment

• Assess wound for proper healing
  – Examine dressings for excess drainage
    • Change saturated dressings to prevent contamination of wound
  – Examine wounds for early signs of infection or delayed healing
    • Inflammation, edema, and bloody drainage are normal during first 3 days but should subside gradually as wound heals

Wound Healing Assessment

• Signs of wound infection
  – Increasing inflammation or edema
  – Purulent drainage
  – Foul odor
  – Persistent pain
  – Delayed healing
  – Enlarged lymph nodes proximal to wound
  – Fever
Wound Healing Assessment

• If any symptoms present, consult with medical direction
  – May advise patient transport to emergency department
  – May direct patient referral to private physician for follow-up care

Special Considerations for Soft Tissue Injuries

• Assessment of life-threatening injuries and resuscitation
  – Precede evaluation of and intervention for non-life-threatening soft tissue injuries
• Treatment
  – Adequate airway, breathing, and circulatory status (with spinal precautions if indicated)
  – Control severe hemorrhage
  – Maintain normal body temperature
  – Proceed with wound care

Penetrating Chest or Abdominal Injury

• Open wounds to chest and upper abdomen must be covered properly with sterile and occlusive dressings
  – Open wounds to neck must also be covered with occlusive dressings to prevent air embolism
  – Open chest wounds can involve severe pulmonary injuries
    • Pneumothorax
    • Tension pneumothorax
Penetrating Chest or Abdominal Injury

- Major complications of penetrating abdominal injury
  - Hemorrhage from a major vessel or solid organ
  - Perforation of segment of bowel

Penetrating Chest or Abdominal Injury

- Guidelines in managing penetrating wound to chest or abdomen in which impaled object is present
  - Do not remove impaled object
    - Severe hemorrhage or damage to underlying structures can occur
  - Do not manipulate impaled object unless it is necessary to shorten object for extrication or for patient transportation

Penetrating Chest or Abdominal Injury

- Guidelines in managing penetrating wound to chest or abdomen in which impaled object is present
  - Control bleeding with direct pressure applied around impaled object
  - Stabilize object in place with bulky dressings
    - Immobilize patient to prevent movement
Avulsion

• Prehospital management
  – If tissue is still attached to body
    • Clean wound surface of gross contaminants with sterile saline
    • Gently fold skin back to its normal position
    • Control bleeding, dress wound with bulky pressure dressings, and maintain direct pressure

Avulsion

• Prehospital management
  – If tissue is completely separated from body
    • Control bleeding with application of direct pressure
    • Retrieve avulsed tissue if possible (do not delay transport to locate amputated body parts)
    • Wrap tissue in gauze, either dry or moistened with lactated Ringer’s or saline solution (per protocol)
    • Seal tissue in plastic bag
    • Place sealed bag on crushed ice; never place tissue directly on ice

Why should you use normal saline or lactated Ringer’s solution instead of sterile water to wrap or clean avulsed tissue?
### Amputations

- Hemorrhage control for amputation should be managed initially with direct pressure
  - Severe amputation may require use of tourniquet
    - Can cause tissue damage and may interfere with reimplantation attempts
    - Direct pressure is preferred method to control bleeding
  - Amputated limb should be retrieved and managed in same manner as avulsed tissue

### Crush Syndrome

- Complex and difficult to diagnose and treat because of many variables involved
  - Extent of tissue damage
  - Duration and force of compression
  - Patient's general health
  - Associated injuries
- Management of crush syndrome is controversial

### Crush Syndrome

- Medical direction physician familiar with this pathological process must supervise prehospital care
  - Scenarios where crush injury may occur
    - Earthquakes where victims are trapped in collapsed buildings
    - People who have laid immobile in one position (e.g., from stroke or alcohol intoxication) for long periods of time
Crush Syndrome

• Consider possible crush syndrome when prolonged immobilization or compression occurs
  – Emergency care must be coordinated with rescue efforts so timing of release from entrapment follows medical treatment
  – Will help to prevent hypovolemic shock and crush syndrome

Crush Syndrome

• Treatment
  – Ensure adequate airway and ventilatory support
  – Aggressive IV hydration to manage hypotension and to prevent renal failure
  – Other care at scene should be guided by on-scene or on-line medical direction

Summary

• Hemorrhage can be internal or external
• Skin and its accessory organs are main cosmetic structures of body
  – Structures perform many functions critical to survival
  – Skin is composed of two distinct layers of tissue
    • Outer layer (epidermis)
    • Inner layer (dermis)
Summary

• Surface trauma can disrupt normal distribution of body fluids and electrolytes
  – Surface trauma also can interfere with maintenance of body temperature
  – Two physiological responses to surface trauma
    • Vascular and inflammatory reactions
  – Can lead to healing, scar formation, or both
  – Many factors can affect or alter wound healing

Summary

• Soft tissue injuries are classified as closed or open
  – Classification is determined by the absence or presence of a break in continuity of the epidermis
  – Closed wounds include contusions, hematoma, and crush injury
  – Open wounds are classified as abrasions, lacerations, punctures, avulsions, amputations, and bites

Summary

• Assessment of life-threatening injuries and resuscitation precedes evaluation and intervention of non-life-threatening soft tissue injuries
  – General wound assessment should include history of event that caused wound and careful examination of injury
  • Methods of hemorrhage control include direct pressure, immobilization by splinting, pneumatic pressure devices, and tourniquets
Summary

- General categories of dressings used in trauma care are sterile, nonsterile, occlusive, nonocclusive, adherent, and nonadherent
  - General categories of bandages are absorbent, nonabsorbent, adherent, and nonadherent
- Depending on nature and location of patient’s injury, cleansing, dressings, bandages, and immobilization may be indicated to care for wound properly

Summary

- Goals of wound care are to prevent infection and protect from infection
  - Factors that influence likelihood of infection include unclean wounds and wound mechanisms and patient’s poor state of health
- Special considerations for specific wounds include penetrating chest or abdominal injury, avulsion, amputation, and crush syndrome

Questions?