Tissue Response to Injury
Overview

• Although highly complicated and not fully understood, the basis of inflammation and the healing process should be studied as foundation of initiating proper injury management.
Overview

Soft tissue healing consists of 3 major phases:

1) the acute phase in which the fundamental reaction is to protect, localize, and rid the body of some injurious agent in preparation for healing and repair.

2) The fibroblastic repair phase in which resolution occurs, scar tissue may be formed, or regeneration occurs.

3) The remodeling phase in which the healing cycle is completed.
Overview

• The healing of bony tissue involves similar steps, with some differences.

• Bone heals by forming a soft callus at the fracture site, which creates a rigid immobilization. This changes into a hard callus by gradually connecting the bone filaments to the woven bone; eventually new bone is created.
Overview

• Another important consideration in discussing tissue response to injury is the element of pain perception. There are currently a number of neuropsychological theories explaining pain perception. The athletic trainer should have a basic knowledge of these to assist in giving total treatment to an injured athlete.

• With an understanding of tissue healing & pain the athletic trainer can determine the proper treatment procedures to follow ensuring a safe and rapid return to the athletes pre-injury status.
The Healing Process

1. Inflammatory Response Phase
   a) Vascular reaction: involves vascular spasm, formation of a platelet plug, blood coagulation and growth of fibrous tissue
   b) Formation of a clot: Platelets adhere to the collagen fibers to create a sticky matrix on the vascular wall, to which additional platelets and leukocytes adhere - forming a plug
1. Inflammatory Response Phase
   c) Chronic Inflammation: occurs when the acute inflammatory response doesn’t eliminate the injuring agent and restore tissue to its normal physiological state
The Healing Process

2. Fibroblastic Repair Phase
   a) Proliferation and regeneration leading to scar formation and repair of the injured tissue follows the vascular and exudative phenomena of inflammation
The Healing Process

3. Maturation-Remodeling Phase
   a) Long-term process - realignment of remodeling of the collagen fibers that make up scar tissue occurs according to the tensile forces to which the scar is subjected
   b) May require several years to complete
The Healing Process

4) The Role of Progressive Controlled Mobility During the Healing Process
   a) Wolff’s Law- Bone and soft tissue will respond to the physical demands place on them, causing them to remodel or realign along lines of tensile force
   b) Injured Structures must be exposed to progressively increasing loads throughout the rehabilitative process
The Healing Process

5) Factors that Impede Healing
   a) Extent of Injury
   b) Edema
   c) Hemorrhage
   d) Poor Vascular supply
   e) Separation of Tissue

1. Primary Intention
2. Secondary intention
The Healing Process

5. Factors that Impede Healing
   f) Muscle Spasm
   g) Atrophy
   h) Corticosteroids
      1. Steroid use in early stages of healing has been demonstrated to inhibit fibroplasias, capillary proliferation, collagen synthesis, and increases in tensile strength of the healing scar
The Healing Process

5. Factors that Impede Healing
   i) Infection
   j) Humidity, Climate, and Oxygen Tension
      1. Humidity influences the process of epithelization
      2. Occlusive dressings stimulate epithelium to migrate twice as fast without crust or scab formation
      3. Optimal saturation and maximal tensile development occurs from oxygen tension
The Healing Process

5. Factors that Impede Healing
   k) Health, Age, and Nutrition
Soft-Tissue Healing

1. Cell Structure an Function
   a) All tissues of the body can be defined as soft tissue except bone
   b) Four types of soft tissue (epithelial tissue, connective tissue, muscle tissue and nervous tissue)
Soft-Tissue Healing

1. Cell Structure and Function
   a) Soft tissue adaptations
      I. Metaplasia: conversion of one kind of tissue into a form that is not normal for the tissue
      II. Dysplasia: Abnormal development of tissue
      III. Hyperplasia: excessive proliferation of normal cells in the normal tissue arrangement
Soft-Tissue Healing

1. Cell Structure and Function
   a) Soft tissue adaptations
      IV. Atrophy: decrease in the size of tissue due to cell death and resorption or decreased cell proliferation
      V. Hypertrophy: increase in the size of a tissue without necessarily increasing the number of cells.
Soft-Tissue Healing

2. Cartilage Healing
   a) Limited healing capacity
   b) Injuries to articular cartilage alone fail to elicit clot formation or a cellular response
3. Ligament Healing
   a) Factors Affecting Ligament Healing
       I. Non-repaired ligaments heal by fibrous scarring- lengthens ligament and produces joint instability
       II. Actively exercised ligaments are stronger than those immobilized
Soft-Tissue Healing

3. Ligament Healing

a) Factors Affecting Ligament Healing

III. Immobilization causes decrease in tensile strength and weakening of the insertion on the bone

IV. Not likely that inherent stability of the joint provided by the ligament prior to injury will be regained
4. Muscle Healing

a) Collagen fibers undergo maturation and orient themselves along lines of tensile force- Wolff’s law

b) Active contraction of the muscle is critical in regaining normal tensile strength
Soft-Tissue Healing

4. Muscle Healing
   c) Regardless of the severity of the strain-
      time required for rehab is fairly lengthy –
      many instances rehab time is longer for a
      strain than for ligament sprain
   d) Strains may take as long as 6-8 weeks to
      heal
Soft-Tissue Healing

5. Tendon Healing
   a) Collagen synthesis can become excessive, resulting in fibrosis-adhesions form in surrounding tissues and interfere with gliding
   b) Over time-the scar tissue will become elongated due to break down of cross-links between fibrin units and allow the necessary gliding
5. Tendon Healing

c) Typical time frame for tendon healing:

i. During 2\textsuperscript{nd} week- healing tendon adheres to the surrounding tissue to form a single mass

ii. During the 3\textsuperscript{rd} week- tendon separates to varying degrees from the surrounding tissues

iii. Tensile strength is not sufficient to permit a strong pull on the tendon for at least 4-5 weeks
6. Nerve Healing
   a) Specialized tissue- nerve cells- cannot regenerate once the nerve cell dies
   b) Injured peripheral nerve- the nerve fiber can regenerate significantly if the injury does not affect the cell body
6. Nerve Healing

c) The closer the injury is to the cell body, the more difficult the regeneration process.
d) Severed nerve- surgical intervention can enhance regeneration.
e) Regeneration is slow- 3.4 mm/day.
Soft-Tissue Healing

7. Modifying Soft-Tissue Healing
   a) Use of Anti-inflammatory Medications
   b) Therapeutic Modalities
   c) Therapeutic Exercise
Soft-Tissue Healing

8. Bone Healing

a) In one week, fibroblasts begin laying down a fibrous collagen network

b) Fibrin strands within the clot serve as framework for proliferating vessels
Soft-Tissue Healing

8. Bone Healing
   c) Chondroblast cells produce fibrocartilage - creates callus between broken bones
   d) Osteoblasts begin to proliferate and enter the callus, forming cancellous bone trabeculae - Callus crystallizes into bone - bone remodeling begins
8. Bone Healing

e) Remodeling involves osteoblasts laying down new bone and osteoclasts removing and breaking down bone according to forces placed on the new bone- Wolff’s law

f) Time for bone healing based on severity of fracture, site of fracture and extensiveness of trauma and age of patient

g) Osteoblastic and osteoclastic activity may continue for 2-3 years after severe fractures
9. Management of Acute Fractures
   a) Conditions that may interfere with bone healing
      i. Poor blood supply to the fractured area- avascular necrosis
      ii. Poor immobilization of the fracture site
      iii. Infection
      iv. Poor bone union due to soft tissue interference between bone ends
10. Healing of Stress Fractures
   a) Healing involves restoring a balance between osteoclastic and osteoblastic activity
   b) Stress fractures that go unhealed will eventually develop into complete cortical fractures that may become displaced over time
Pain

1. Types of Pain
   a) Pain Sources
      i. Cutaneous pain- usually sharp, bright and burning, fast or slow onset
      ii. Deep somatic pain stems from tendons, muscles, joints, periosteum and blood vessels
Pain

1. Types of Pain

a) Pain Sources

iii. Visceral pain originates from internal organs - diffuse at first and later becomes localized

iv. Psychogenic pain is caused by emotion rather than a physical cause
Pain

1. Types of Pain
   a) Pain Sources
      iii. Visceral pain originates from internal organs- diffuse at first and later becomes localized
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   a. Acute Versus Chronic Pain
   b. Referred Pain
Pain

2. Nociceptors and Neural Transmission
   a) Pain receptors = nociceptors or free nerve endings are sensitive to mechanical, thermal and chemical energy
   b) Commonly found in skin, periosteum surrounding bone, teeth, meninges and some organs
Pain

3. Mechanisms of Pain Control
   a) Gate Control Theory

4. Treating Pain
   a) Therapeutic Modalities
   b) Medications
   c) Psychological Aspect of Pain