High-Volt Pulsed Stimulation

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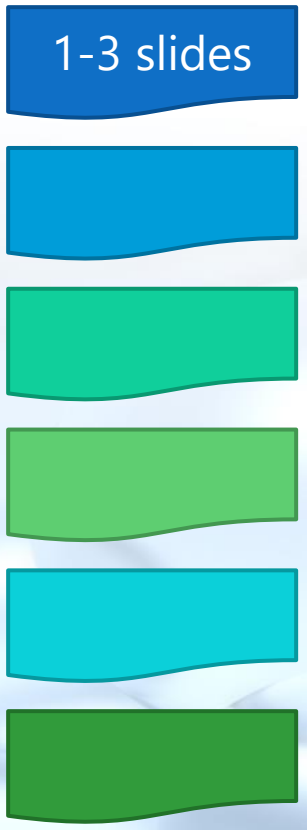
Summary Layout



Electrical Principles

High Voltage Pulsed Stimulation

Application Techniques

factors influencing to biological and physiological responses

Physiological and Therapeutic Effects

Phases of wound healing.

Ampere

Unit of current

- RATE which electrons pass a given point
- 1 ampere = 1 coulomb / second
- Coulomb is a unit of electrical charge
  - Indicate the number of electrons
- Measured in milliamperes (1/1000)

  microamperes (1/1,000,000

voltage

Electromotive force (EMF) or Electrical Potential Difference

- Greater the difference, greater potential for electron flow

Measured in Volts (V)

- Potential difference necessary to move 1 amp of current in 1 sec against a resistance of 1 ohm

High voltage = above 100 or 150 volts

Low voltage = below 100 or 150 volts

Ohm’s Law

$$\text{Amperes} = \frac{\text{Voltage}}{\text{Resistance}}$$

كمية الطاقة الكهربائية التي تمر في موصل :
1واط=1فولت×1أمبير.
الطاقة الكهربائية=الجهد×التيار.
قدرة المصدر على توليد
الطاقة=جـ(المصدر)×ت(المصدر).

Frequency selection:

In monophasic pulses

100Hz - pain relief

50-60 Hz = muscle contraction

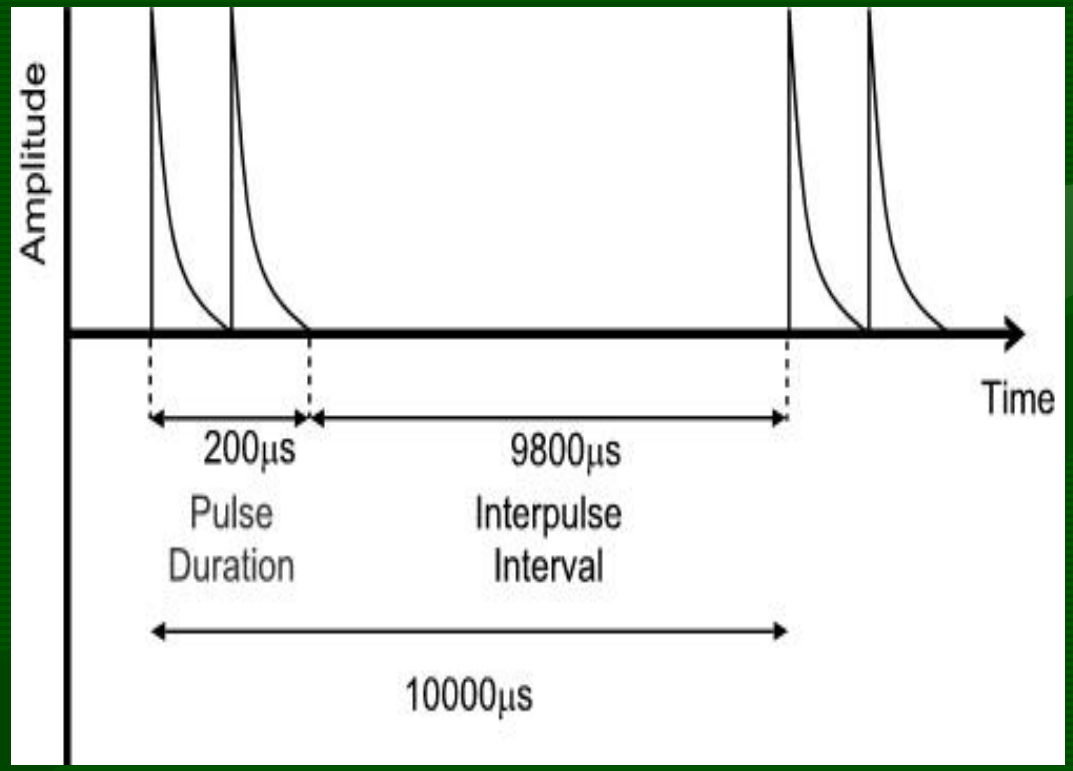
1-50 Hz = increased circulation

The higher the frequency (Hz) the more quickly the muscle will fatigue

What is High Voltage Pulsed Stimulation?

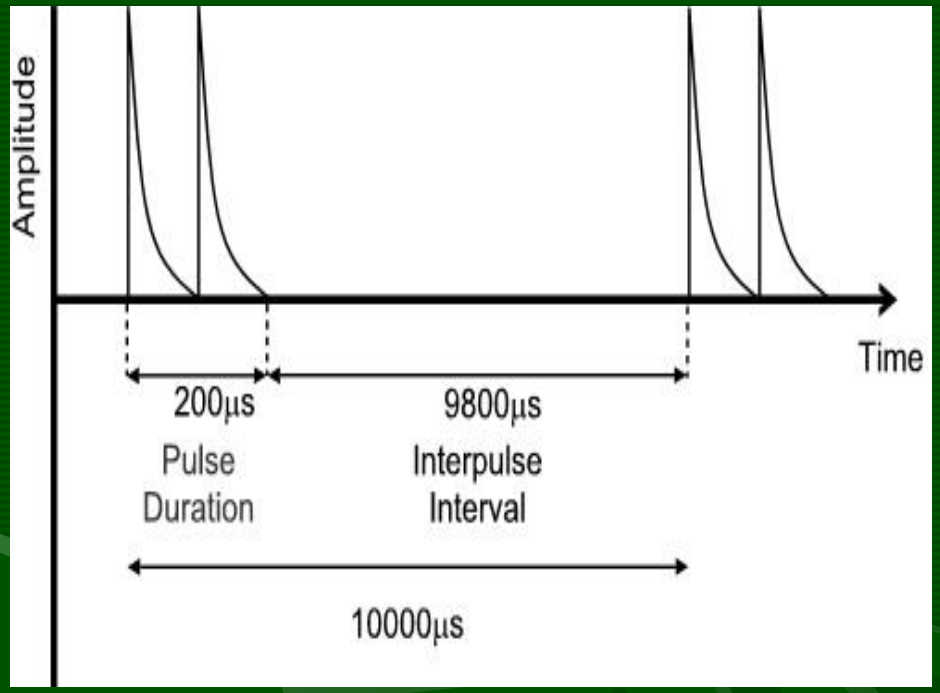
- Twin Peaked, Monophasic, Pulsed Current Phase duration is relatively short 20-45 μsec

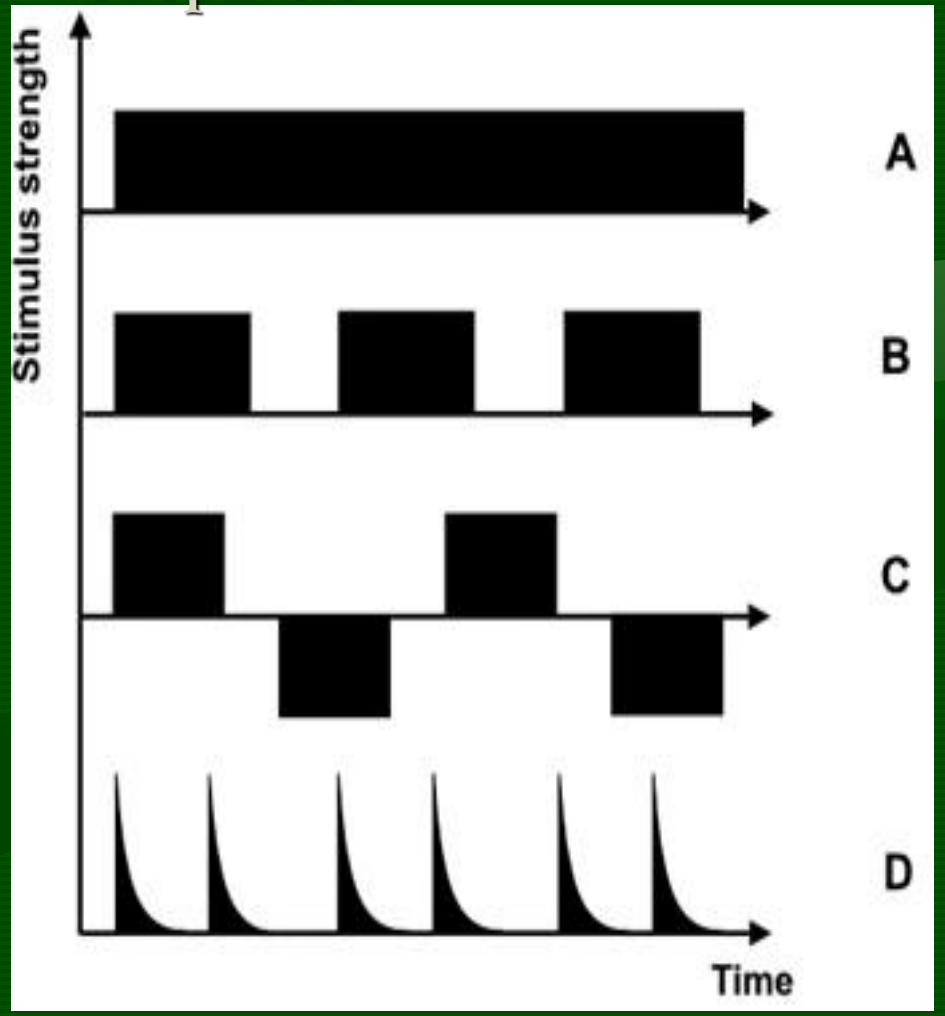
- Interpulse interval Resulting in a short pulse duration – up to 200 μsec



- Low total current
- Known polarity under each electrode
- Purported that little or no electrochemical reaction occurs under the electrode

(A) direct current (B) monophasic pulsed DC (C) symmetric biphasic pulsed (D) twin peak monophasic





twin peak monophasic

Characteristics of HVPC

Waveform : Monophasic twin-peak wave

A. Pulse Duration : 100 μs (Very Short)

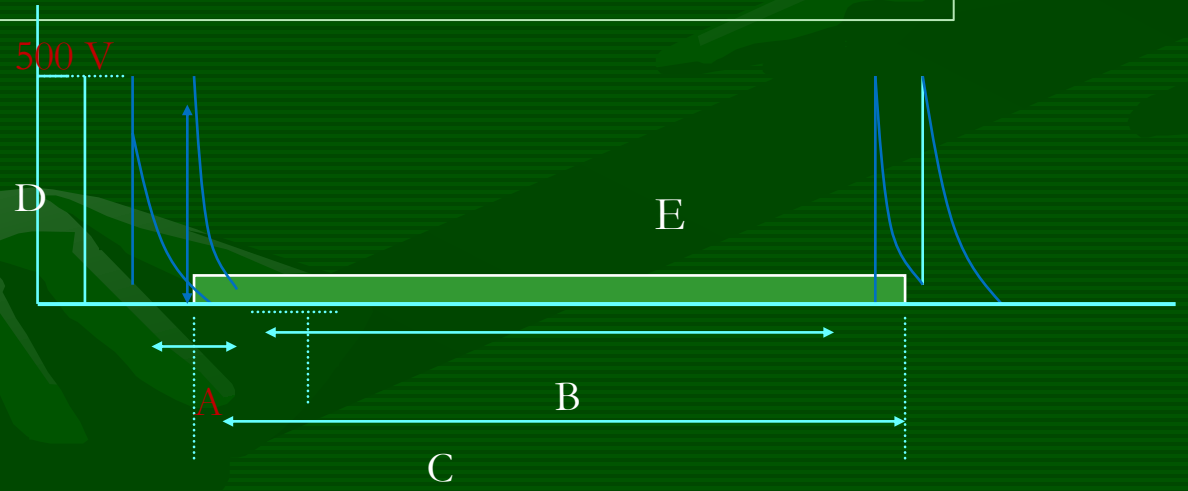
B. Inter pulse Interval : 9900 μs (Very Long)

C. Duty Cycle : A + B = 10000 μs (10 ms)

D. Peak Amplitude : 500 V

Peak Current : 400 mA (Very High)

E. Average Current : 1.5-2 mA (Very Low)



Characteristics of High-Volt Stimulator

- Low volt stimulators generate <150 V
- High volt stimulators generate >150 V
- HVPC uses between 150 and 500 V.
- Low average current
- Twin peak monophasic waveform
  - Resembles a double spike with a fast rise followed by a fast decline
- Short pulse widths (100–200 μsec)
- Pulse rates of 1–200 Hz
- Generally HVPS uses lower current

High Voltage Pulsed Current Stimulation for Wound Healing

- Electrical stimulation for the purpose of repairing tissues includes management of open wounds and edema reduction.
- Production of a twin-peak, monophasic, pulsed current driven by its characteristically high electromotive force or voltage
- Positive or negative polarity

HVPC Common Treatments

- HVPC can perform several functions:
  - Wound healing (only proven electrical modality to promote wound healing)
  - Pain modulation (acute & chronic)
  - Muscle reeducation and spasm reduction
  - Edema reduction

Review

- What is HVPS stand for? Why isn't it HVGS?
- Describe the HVPS waveform.
- Name the 4 common uses for HVPS.
- Does HVPS utilize high voltage or high current to achieve outcomes?

HVPC: Uses & Techniques

- **Monophasic current used for**
  - **Wound management**
  - **Acute pain reduction**
  - **Reduction of edema**
- Bipolar Technique
  - Bipolar used for muscle contraction or chronic pain **(Note: HVPS is not as effective as NMES for muscle contraction because of lower current in HVPS)**

HVPC: Advantages

1. Less resistance to the current by the skin
2. Short phase duration allows for moderately high-intensity muscle contraction with little discomfort
   - Other types of stimulators provide a stronger contraction

3. **Highly variable in its functions**

Can be used for

- **Wound healing**
- **Pain modulation**
  - **a. Sensory level (acute pain)**
  - **b. Motor level (chronic pain)**
- **Treating muscle weakness**
- **Edema reduction**

HPVC: Disadvantages

Disadvantages

1. Cannot provide as strong of a contraction as NMES
2. Many aren't portable.
3. Sometimes trial and error are needed to determine electrode polarity for wound healing.
4. Effects (muscle contraction) are not as strong as low-volt units.

HPVC: Indications & Contraindications

Indications

1. Wound lesions (pressure sores, scarring from incisions)
2. Edema control and reduction
3. Residual or chronic muscle spasm (when low-volt unit unavailable)
4. Pain

Contraindications

1. Do not use on patient with pacemaker
2. Do not use over
   a. Heart or brain
   b. Lumbar and abdominal area of pregnant women
   c. Potential malignancies
   d. Anterior cervical area

HPVC Precautions

Precautions

1. **Be cautious when using HVPC over an area with:**
   a. **Impaired sensation**
   b. **Extensive torn tissue (no use of bipolar)**
   c. **Hemorrhagic area**
2. **Patients with epilepsy should be monitored during treatment.**

Review

- What are the monopolar and bipolar uses of HVPS?
- Name the 4 advantages of HVPS?
- Name the 4 disadvantages of HVPS?
- What are the 4 indications for HVPS?
- What are the 5 contraindications for HVPS?
- What are the 4 precautions for HVPS?

HVPC: Wound Management

- How does HVPC stimulate wound repair?
  - Body possesses bioelectric currents in the vascular and interstitial tissues.
  - Blood vessel walls, insulating tissue matrix, interstitial fluid, and intravascular plasma are capable of conducting bioelectricity.
  - When tissues are damaged, an electrical potential is created between injured and noninjured tissues.

HVPC: Wound Management (cont.)

- Polarity may stimulate cellular activity when injured.
- Stimulating débridement of injured tissues
- Tissue regeneration and remodeling
- May speed up healing by promoting the natural healing process
- May develop a difference in potential between wound area and the surrounding healthy tissue
- Injury potential typically becomes positive 24–48 hr after injury & negative 8–9 days after injury.
- As the wound heals, the difference slowly returns to baseline.
  - Can be used to enhance the natural process of tissue recovery and healing

HVPC: Edema Management

- Curbing edema formation
  - HVPC does not use DC
  - Decreases the permeability of microvessels
  - Decreases the leaking of vessels, reducing the number of plasma proteins and amount of fluid that leave the vessels to enter the interstitial spaces

HVPC: Edema Management (cont.)

- Two protocols for curbing edema

Water immersion

-Negative polarity

-120 pps sensory

-90% of visible motor threshold

-30 min treatments every 4 hr

-Resolution of edema once formed

-Can be employed in a muscle pumping action to get rid of edema motor

-Intensity increased until strong muscle contraction

-Setting of 1–10 pps for muscle contraction

Under water HVPS

Pain control

Pain Control Roles: Control acute or chronic pain both sensory (gate control - 100-150 pps)) and motor level (opiate release – through voltage)

Parameter Setting for Gate Control Method

Intensity	Sensory
Pulse frequency	60-100 pps
Phase Duration	< 100 *u*sec
Mode	Continuous
Placement	Directly over pain site

Pain Control - Opiate Release Setting

Parameter Setting	**Opiate Release**
Intensity	Motor Level 150V
Phase Duration	150-250 msec
Pulse frequency	2-4pps
Mode	Continuous
Placement	Directly over pain site

HVPC: Electrode Polarity

- Negative polarity
  - Increases
    - Vascularity
    - Stimulation of fibroblastic growth
    - Collagen production
    - Epidermal cell migration
  - Inhibits bacterial growth
- Positive polarity
  - Increases macrophages
  - Promotes epithelial growth

HVPC: Electrode Polarity (cont.)

- Most treatments begin with the negative polarity
  - Encourages blood clots to dissolve and increases the inflammatory by products
    - Necrotic tissues
- Positive polarity encourages clot formation around the wound and granulation tissue.

REVIEW: Phases of the Inflammatory Process

- Phase I: Acute Phase (2 subphases)
  - Early (Acute): inflammatory response: lasts 2-4 days
  - Late (Sub-Acute): continue inflammatory phase which is usually complete in 2 weeks
- Phase 2: Tissue Formation (Proliferation)
  - Tissue rebuilding approximately 2-3 weeks
  - This does not include chronic inflammation
- Phase 3: Remodeling Phase
  - Adapt to original tissue
  - Continues for up to 1 year post injury

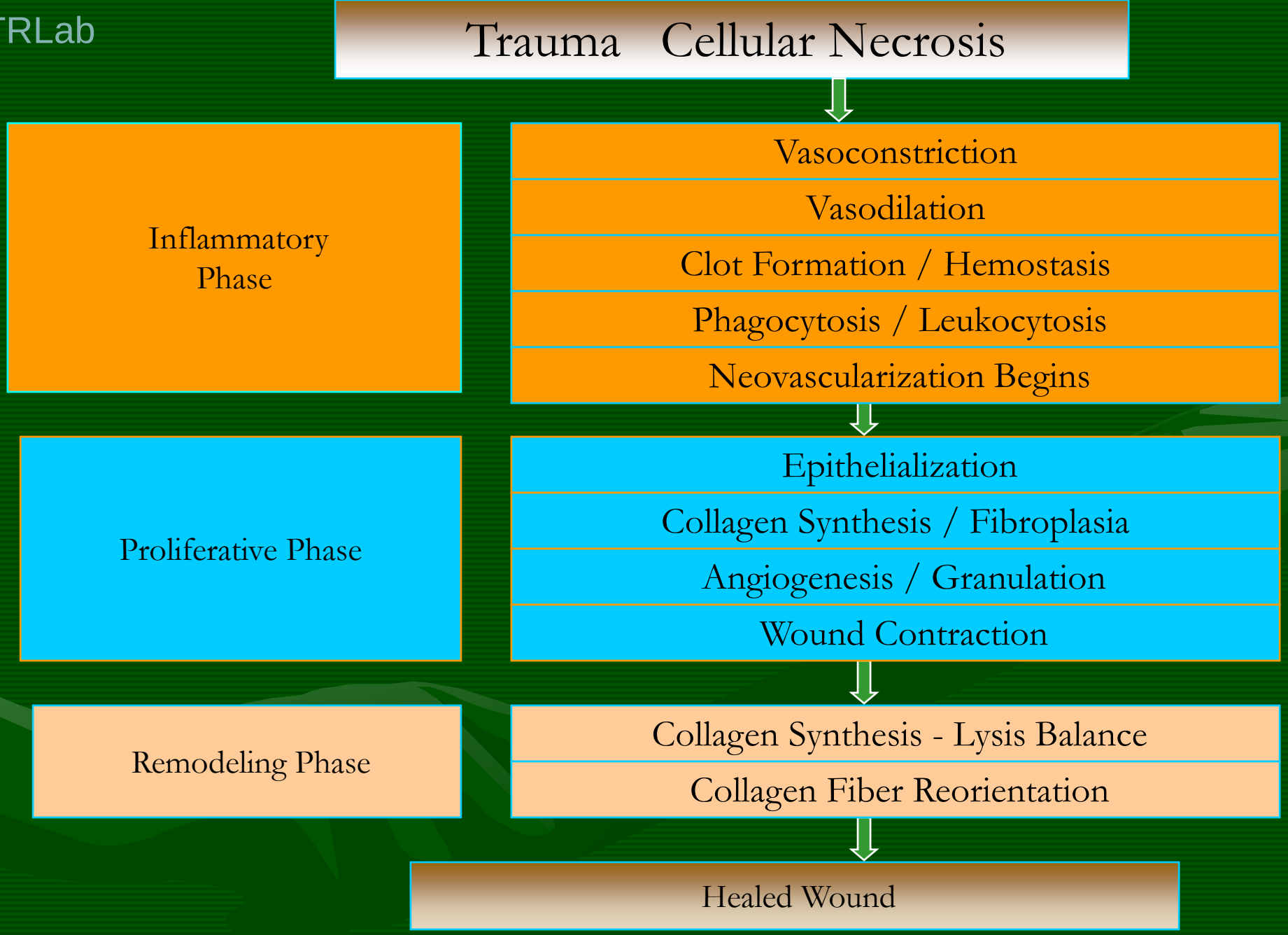
REVIEW: Phase II, Stages of Regeneration

- Stage starts with periphery/outside
- **Re-eptheliaization is proliferation of peripheral epithelial tissue which then migrates to the wound until the area is covered.**
- **Capillarization (Capillary buds proliferate and connect forming new capillaries which gives the red, granular appearance to the scar (granular tissue)**

REVIEW: Chronic Inflammation

- Complications
  - Granuloma: large mass of weaker scar tissue (usually due to large inflammation and activity without regard to healing time)
  - Retardation of muscle fiber: with excessive granuloma fibroblasts cannot reach damaged tissue
  - Adhesions/contractures in tissue
  - Keloid/hypotrophic scars

ETRLab



Flow Chart of Wound Healing

Application Parameters: HVPC

- Frequency of application

  As often as three per day if separated by 3–4 hr

- When using the monopolar function, active electrode over the injury and dispersive over a large & remote site
- When using the bipolar function, place electrodes proximal & distal to the muscle belly
- Length of application

  15 min if pulsed or patient is going to exercise post treatment

  15 to 30 min if surge mode is used or patient is not going to exercise post treatment (longer tires out the muscle)

Review

- How does HVPS stimulate wound repair (10 ways)?
- What are the 2 ways HVPS manage edema? What are the 2 protocols?
- What are the 5 things negative polarity in HVPS effects? What are the 2 things positive polarity in HVPS effects?
- What are the common pad placements, duration and frequencies of treatment w.r.t. HVPS?

factors influencing to biological and physiological responses.

- Pulse duration (pulse width)
- Peak current
- Pulse rate (frequency)
- Pulse charge

Factors Influencing to Biological and Physiological Responses

1. **Pulse duration (pulse width)**

- **Degree of chemical effect**
- **Degree of thermal effect**
- **Excitation responses of nerve fiber type**
- **Degree of comfortability**
- **Lowering the Average Amperage**

- **Monophasic wave (DC, IDC, Diadynamic current) : 1-300 ms, more than**
- **Monophasic wave (HVPC) : 30-200 μs**
- **less chemical & thermal effect, safely use for long duration**
- Comfortability

Factors Influencing to Biological and Physiological Responses

2. Peak Current

- Penetration Depth is proportion to Current Intensity

Low peak current – higher resistance, thermal effect, superficial vessel dilation

High peak current – lower resistance, no thermal effect, stimulate deeper tissue.

* Developed to produce deeper tissue stimulation without tissue damage

Factors Influencing to Biological and Physiological Responses

- **3. Pulse rate (frequency)**
- • Contraction type
- 1-15 pps : Single contraction
- 15 pps ↑: Tetanic contraction
- • Higher PR induce Muscle fatigue
- 20-40 pps ↑
- On-Off ratio

Physiological and Therapeutic Effects

1. **Pain relief**
   - Gate control theory : High Frequency (Conventional TENS)
   - Endogenous inhibition : Low Frequency (Acupuncture TENS)
   - Nerve Blocking : Anode (+) decreases nerve irritability by raising the nerves resting potential

2. **Muscle spasm relief**
   - **Muscle fatigue**
   - **Disruption of pain-spasm cycle**
   - **Contraction – Relaxation**

3. **Promote inflammation resolve (Wound healing)**

4. Edema absorption

edema formation:endothelial wall permeability of capillary ↑

excess plasma proteins to escape into the tissue spaces (exudation ↑)

hydrophilic albumin attracts water → Edema (expansion of tissue spaces)

1) Fluid shift out of area

Negative pole : dissolve Blood cell

repel Serum protein (albumin) - negative

2) Absorbs fluid by lymph stimulation

- Sensory stimulation – stimulate lymphatic system

3) Muscle pumping

- Motor stimulation

4) Reduced microvascular leakage

BIOLOGICAL EFFECTS OF ESTR

5. **Reduced Edema**

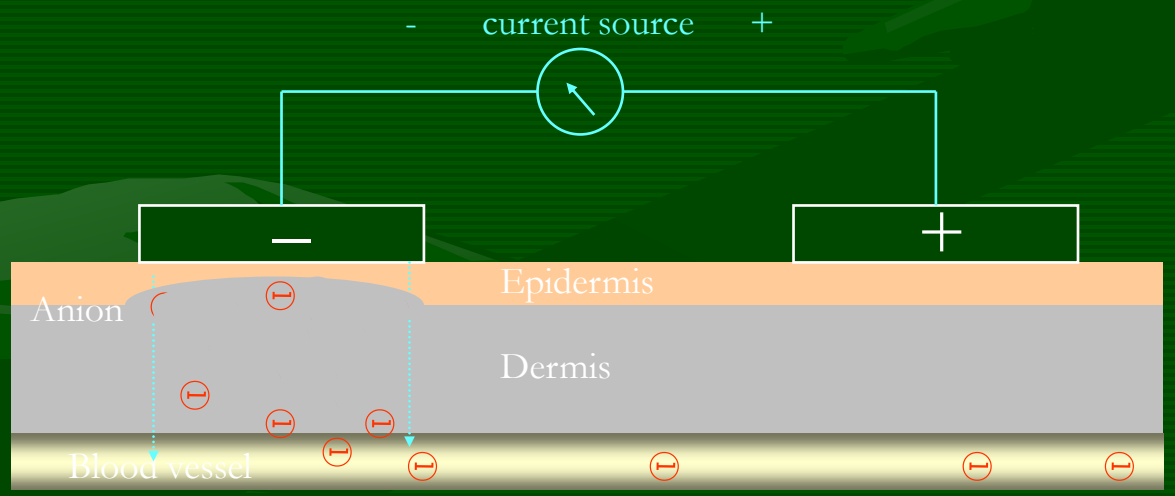
1) fluid shift out of area

Electrorepulsion

Negative pole

dissolve Blood cell

repels blood cells, plasma proteins (albumin - hydrophilic, negative)



Polarity Effect With DC Current

Positive	Negative
Attracts acids	Attracts alkali
Repels alkali	Repels acids
Hardens tissue	Softens tissue
Contracts tissue	Dilates tissue
Stops hemorrhage	Increases hemorrhage
Diminishes congestion	Increases congestion
Sedating	Stimulating
Relieves pain in acute conditions by reducing congestion	Reduces pain in chronic conditions because of softening effect
Scars formed are hard and firm	Scars are soft and pliable

5. Increase joint mobility

- Pain relief
- Edema absorption
- Increase microcirculation
- Mechanical stretching

6. Improve muscular atrophy (Neuromuscular stimulation)

- Muscle atrophy retardation
- Increase enzyme activity
- Pain modulation
- Isolated muscle contraction
- Increase joint mobility
- Inhibit spasticity

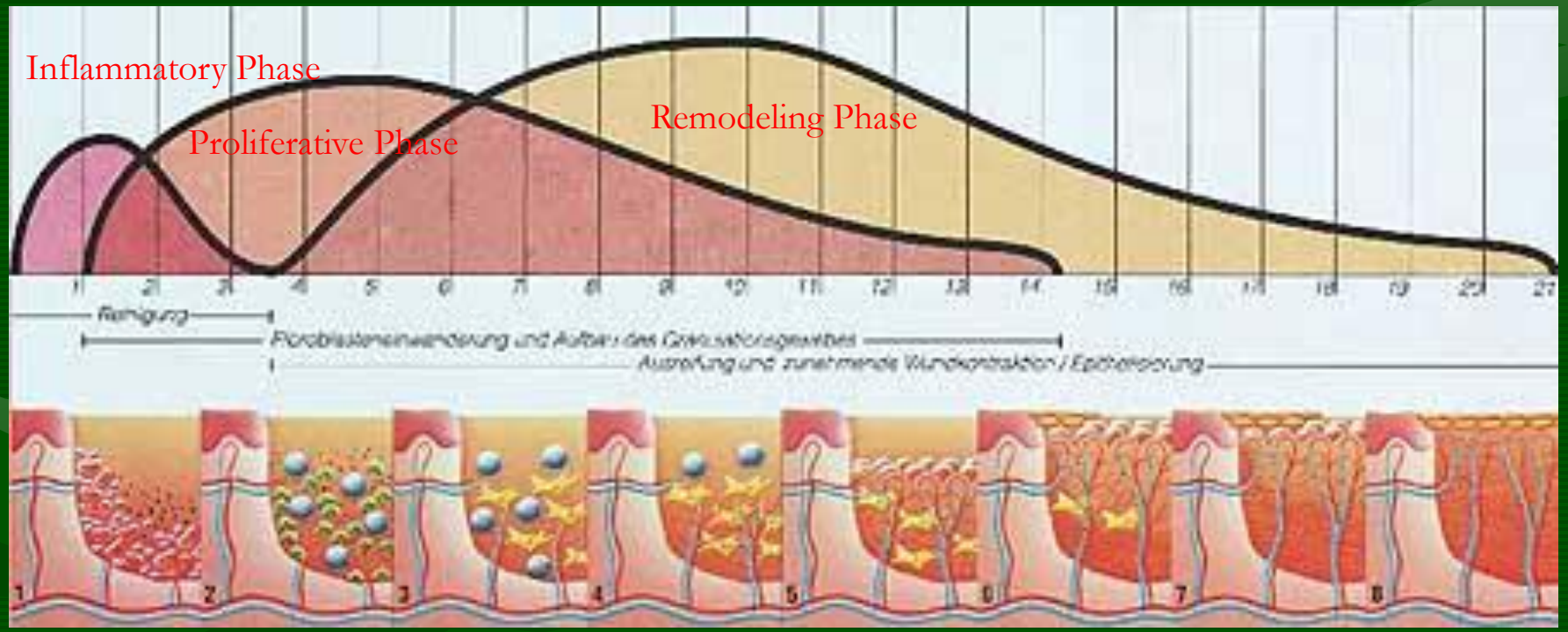
7. Increase peripheral circulation
   - Direct sympathetic activation
   - Somatic sympathetic reflex
   - Muscle pumping action
   - Muscle metabolism

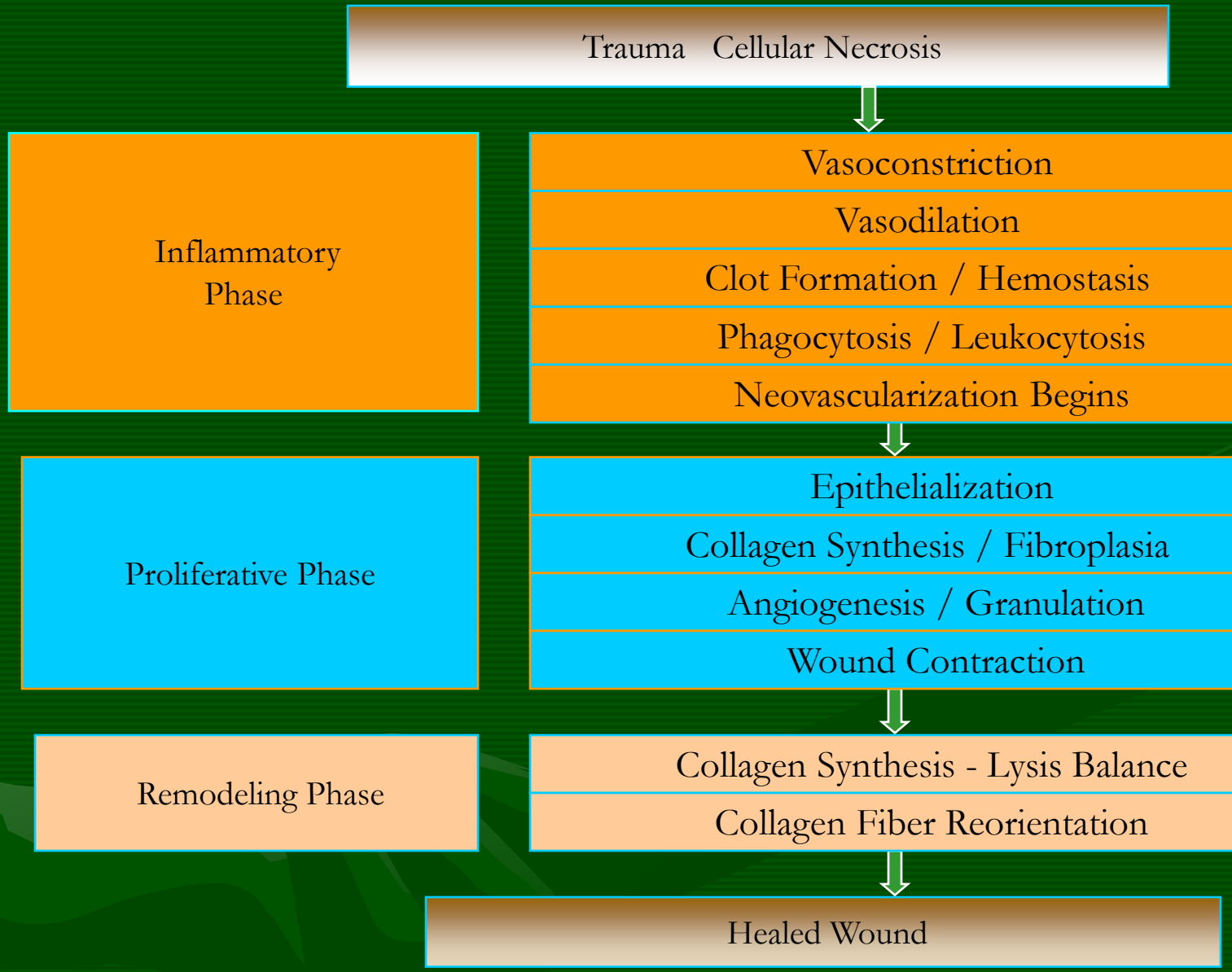
8. Promote wound healing

8. Promote wound healing

Phases of the Wound Healing

1. Inflammatory Phase : at the moment of injury – 3 (2-5) days
2. Proliferative Phase : 3 (2-5) day to 20 days
3. Remodeling Phase : 9 days to 18 (24) months





Flow Chart of Wound Healing