

High-Volt Pulsed Current: Treatment of Skin Wounds and Musculoskeletal Injuries

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High-volt pulsed current (HVPC) was developed in the 1940s by American scientists at Bell Laboratories. HVPC consists of twin-peak, monophasic pulses of very short duration (less than 200 ms) that are driven at 150 to 500 volts. The primary purpose for administration of HVPC is to accelerate the healing process for cutaneous wounds. It is also used for prevention of edema formation, muscle reeducation, muscle spasm reduction, and pain modulation.

KEY POINTS

▶ The primary purpose for administration of high-volt pulsed current is to accelerate the healing process for skin wounds.

▶ High-volt pulsed current may also be beneficial for prevention of edema formation, muscle reeducation and spasm reduction, and pain modulation.

▶ Proper treatment parameter selection is important to derive optimal therapeutic benefits from high-volt pulsed current.

septic diabetic abscess in a single patient. HVPC is believed to augment weak endogenous skin voltage, which promotes wound healing. Wound management with HVPC involves administration of high-frequency, low-amplitude stimulation, which creates a skin stimulus that many patients describe as a “pins and needles” sensation. Most of the

research on HVPC has been focused on management of pressure ulcers. The combination of HVPC with whirlpool treatment has been reported to have no greater effect on pressure ulcers than HVPC alone.² Pressure ulcers treated by HVPC for 45 minutes per day and five times per week have been reported to completely heal within 7.3 weeks, while those not treated with HVPC increased in size by 29%.³ Other researchers have reported that pressure ulcers treated with HVPC (220 V; 100Hz) for 1 hour per day over a 20-day period decreased by 80%, compared to 52% for a control group.⁴

Theory: How HVPC Works

HVPC involves a strong electromagnetic force that always exceeds 150 volts (maximum of 500 volts). A “galvanotaxis effect” induces the migration of polarized cells toward either the cathode or anode. The migration of neutrophils, macrophages, lymphocytes, and platelets is believed to stimulate the “inflammatory phase” of the tissue healing response. Subsequent migration of fibroblasts to the wound site enhances synthesis of new tissue during the “proliferation phase” of the healing response. Migration of epidermal cells and keratinocytes is beneficial during the final “remodeling and maturation phase” of the healing response.⁵

Dermal Wounds

Thurman¹ was the author of one of the earliest reports of the therapeutic use of HVPC on humans, which documented a beneficial effect on healing of a

Administration of HVPC for Treatment of Dermal Wounds

The following are recommended procedures for administration of HVPC for promotion of dermal wound healing.^{3,6,7}

1. Irrigate the wound bed with saline solution.
2. Apply a clean, saline-moistened gauze sponge over the wound.
3. Apply the dispersive sponge electrode approximately 30 cm (12 in) from the wound site.
4. Apply the active sponge electrode directly on top of the saline moistened gauze covering the wound
5. Pulse rate:
 - a. Proliferation phase: 100-128 pps
 - b. Remodeling and maturation (Epithelialization) phase: 64 pps
6. Polarity: negative
 - a. During the epithelialization phase, alternating the polarity between negative and positive every 3 days has demonstrated best results.⁵
7. Set duration timer.
8. Inform the patient that treatment is being initiated.
9. Slowly increase current intensity.
10. Dosage: current intensity should be increased to a level just below that which elicits muscle contraction (usually 100-150 V).
11. Treatment duration: 45-60 min.
12. Treatment frequency: one time per day, 5-7 treatments per week.
13. Duration of therapy: until treatment goals have been achieved.

Rational for Other Therapeutic Applications

Electrical stimulation of deep excitable tissues without eliciting pain presents a clinical challenge. The electrical stimulus duration must be very short, and its amplitude must be very high to avoid depolarization of nerves that convey pain impulses.

Anti-Edema Effect

HVPC is used to limit edema formation and for resolution of edema after it has formed. The anti-edema effect is believed to result from repulsion of nega-

tively charged albumin proteins beneath the cathode, thereby altering the osmotic effect that would otherwise promote outflow of fluid from the capillaries into the interstitium. Laboratory research on the effect of HVPC on edema has produced conflicting findings. Michlovitz et al.⁸ reported no difference in edema control when HVPC was included with the application of ice, compression, and elevation for the treatment of acute ankle sprains. Cosgrove et al.⁹ reported no difference between HVPC and placebo current for edema formation in rats that were subjected to blunt trauma. Conversely, Taylor et al.¹⁰ reported that HVPC was effective in decreasing histamine-induced fluid leakage from blood vessels in hamster cheek pouches. Dolan et al.¹¹ reported that 3 hours of HVPC, or a combination of HVPC and cold water immersion, was effective in limiting edema formation by 50% in rats that were subjected to blunt trauma. Ideally, HVPC treatment should be administered as soon as possible after injury occurrence, and it should be maintained the period that edema formation occurs.¹¹

Muscle Reeducation and Spasm Reduction

Elicitation of a tetanic contraction for muscle reeducation involves administration of high-frequency and high-amplitude electrical stimulation. HVPC is not as effective as other modes of neuromuscular electrical stimulation for this purpose, because its average current is not as great as that generated by low-volt stimulators.¹² We recommend that an HVPC stimulator should only be used for muscle reeducation when no other type of electrical stimulator is available.

HVPC for Pain Modulation

HVPC does not appear to be effective for reduction of delayed-onset muscle soreness;^{13,14} however, HVPC may help to relieve pain associated with muscle spasm.

Administration of HVPC for Treatment of Musculoskeletal Injuries

The following are recommended procedures for administration of HVPC for treatment of a musculoskeletal injury.⁶

1. Set pulse rate:
 - a. Re-education and pain management:
 - < 15 pps for individual or twitch contractions
 - > 50 pps for moderate to tetanic contractions