

Hyperbaric Oxygen Therapy (HBOT): A Novel Treatment for Chronic Pain?

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Лечение комплексного регионарного болевого синдрома

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Treatment of complex regional pain syndrome

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35 patients with complex regional pain syndrome (CRPS) were treated by hyperbaric oxygenation (HBO) and caffetin preparation. A significant decrease of pain was observed in all the patients after the treatment course. Intensity of pain was diminished according to visual analogous scale. Meanwhile considerable regression of autonomic disorders and weakening of anxious and depressive manifestations was noted too. The tendency to normalization of evoked skin potentials was also found. Some elevation of the threshold of nociceptive reflex was conditioned by displacement toward general increase of antinociception after the treatment. Effect of HBO therapy persisted during 6 months in 87% of the patients. Efficiency of caffetin was restricted by the time of its administration. The conclusion was made about possibility of successful treatment of CRPS patients by both methods.

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The Journal of International Medical Research

2004; 32: 258 – 262

Effectiveness of Hyperbaric Oxygen Therapy in the Treatment of Complex Regional Pain Syndrome

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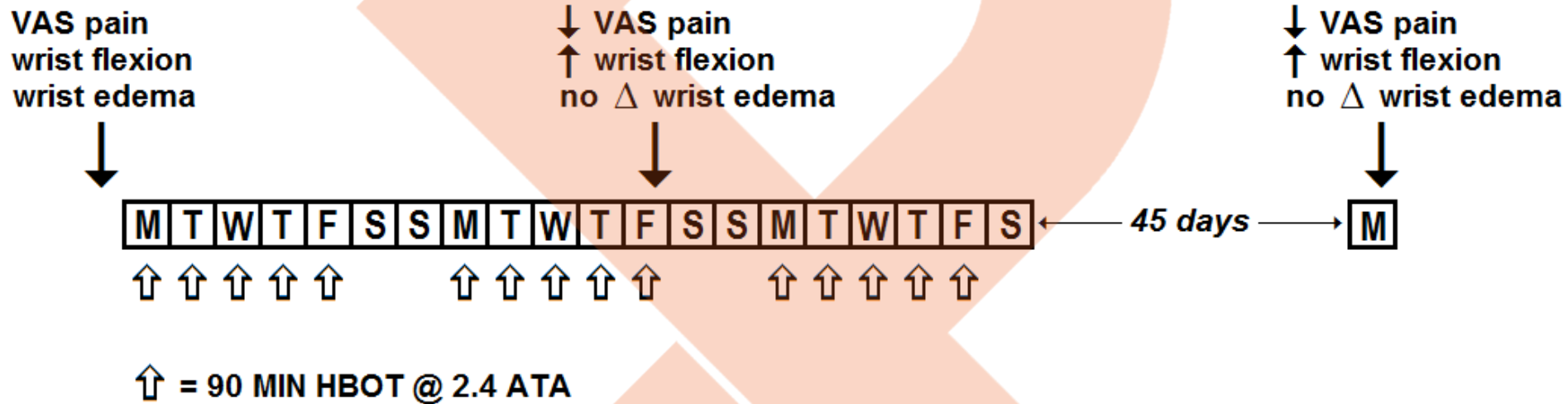
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In this double-blind, randomized, placebo-controlled study we aimed to assess the effectiveness of hyperbaric oxygen (HBO) therapy for treating patients with complex regional pain syndrome (CRPS). Of the 71 patients, 37 were allocated to the HBO group and 34 to the control (normal air) group. Both groups received 15 therapy sessions in a hyperbaric chamber. Pain, oedema and range of motion (ROM) of the wrist were evaluated before treatment,

after the 15th treatment session and on day 45. In the HBO group there was a significant decrease in pain and oedema and a significant increase in the ROM of the wrist. When we compared the two groups, the HBO group had significantly better results with the exception of wrist extension. In conclusion, HBO is an effective and well-tolerated method for decreasing pain and oedema and increasing the ROM in patients with CRPS.

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Case Report



Chronic Regional Pain Syndrome After Subtalar Arthrodesis Is Not Prevented by Early Hyperbaric Oxygen

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Disclaimer: There was no external funding in the preparation of this manuscript.
Conflict of interest: None.

Manuscript received: 02/09/2008
Revised manuscript received: 03/17/2009
Accepted for publication: 04/09/2009

Free full manuscript:
www.painphysicianjournal.com

Subtalar arthrodesis was performed on a 48-year-old, non-insulin-dependent diabetic with a history of chronic ankle instability and lateral ankle pain. In the early post-operative period he presented as an emergency with an infection at the operative site. This was treated with 2 returns to the operating theatre for washout and debridement. His wounds were left open and at 3 weeks after emergency admission he was referred for adjunctive hyperbaric oxygen (HBO) therapy to aid healing by secondary intention. He received a total of 19 hyperbaric sessions, at a pressure of 2.2 ATA, one treatment per day for 5 days a week.

Shortly after commencing HBO therapy his ankle became increasingly painful, despite the introduction of analgesia. By 7 weeks after emergency admission his wounds had virtually healed but hyperesthesia persisted over the dorsum of the foot. A computerized tomography scan at 5½ months post-operatively showed satisfactory joint fusion and revealed no evidence of infection. Symptoms and signs at this time were compatible with a diagnosis of chronic regional pain syndrome (CRPS).

There is published evidence to suggest that HBO therapy may be a useful modality in the treatment of established CRPS. Here, we seek to publicize a case in which early treatment with HBO for another indication did not prevent the simultaneous development of CRPS Type 1.

Key words: Subtalar arthrodesis, hyperbaric oxygenation, chronic regional pain syndrome

Pain Physician 2009; 12:E335-E339

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SUBTALAR ARTHRODESIS OF THE FOOT

↑
1 week
↓

EMERGENCY ROOM VISIT FOR PAIN & INFECTION

↑
3 weeks
↓

BEGIN ADJUNCTIVE HBOT TO AID HEALING

M T W T F S S M T W T F S S

↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑

M T W T F S S M T W T F S S

↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑

↑ = 2x 45 MIN HBOT @ 2.2 ATA WITH 10 MIN INTERVAL BETWEEN SESSIONS

↑
2 weeks
↓

↑
4 weeks
↓

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← CONTINUING PAIN
NEUROPATHIC PAIN

← HYPERESTHESIA

← WORSENER PAIN
ALLODYNIA



Outline

HBOT and Complex Regional Pain Syndrome (CRPS)

- *Three reports from the clinical literature*

HBOT

- *What is it?*
- *FDA-approved HBOT indications*
- *Main effects of HBOT*
- *Off-label uses of HBOT*

HBOT Basic Research Results

- *Mechanism of pain relief may originate in the brain*
- *Mechanism of pain relief may involve the opioid system*

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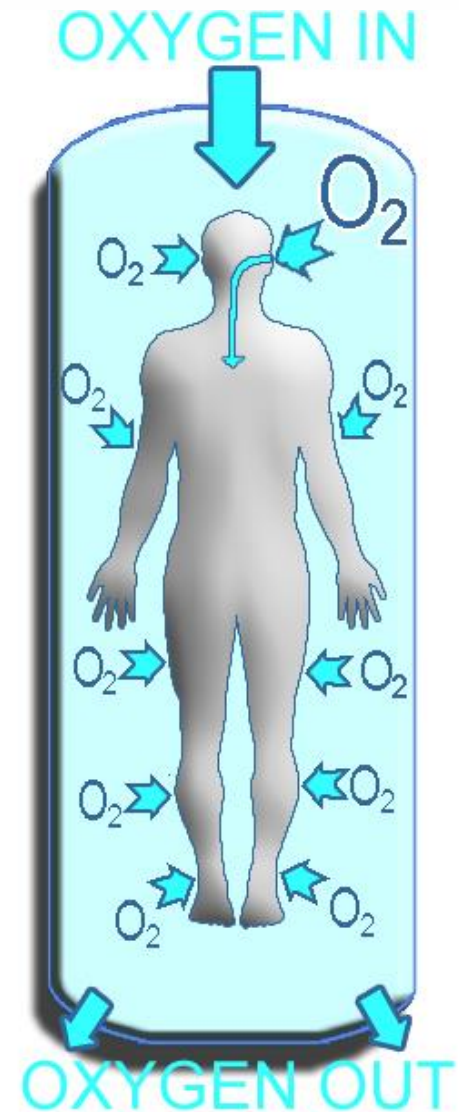
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Hyperbaric Oxygen Therapy (HBOT)

HBOT is the clinical application of 100% oxygen at atmospheric pressures higher than sea level for limited periods of time (60–90 min) to achieve therapeutic outcomes.

HBOT requires the use of a hard shell pressure vessel (hyperbaric chamber).

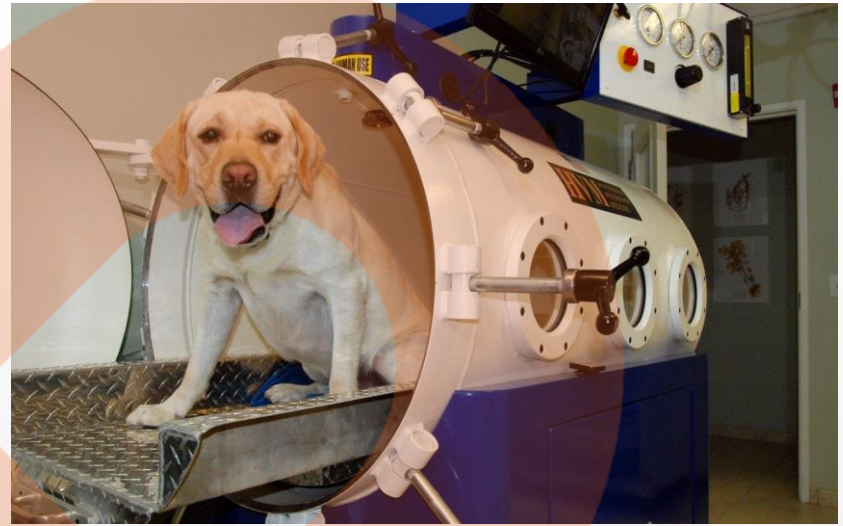
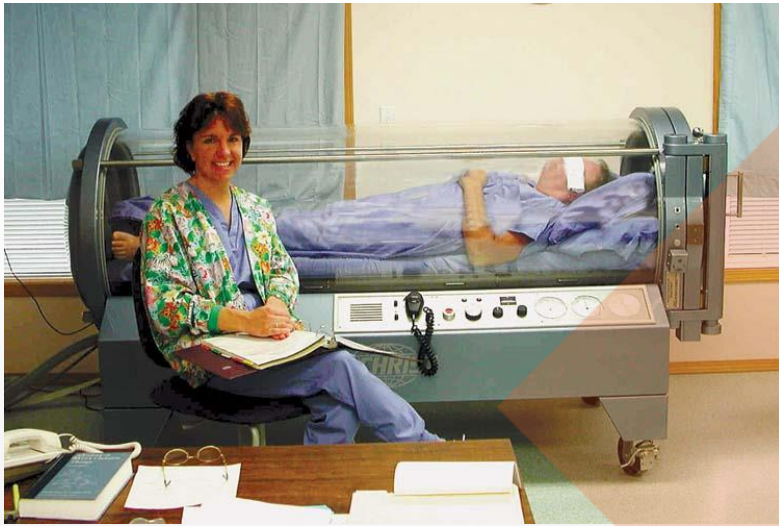


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Hyperbaric Chambers



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FDA-Approved HBOT Indications



- Air or gas embolism
- Carbon monoxide poisoning
- Gas gangrene
- Acute traumatic ischemia
- Decompression sickness
- Arterial insufficiencies
- Severe anemia
- Intracranial abscess
- Necrotizing soft tissue infections
- Refractory osteomyelitis
- Delayed radiation injury
- Compromised skin grafts and flaps
- Acute thermal burn injury
- Idiopathic sudden sensorineural hearing loss

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Main Effects of HBOT

Mechanical Effect of Increased Pressure

- Any free gas trapped in the body will decrease in volume as pressure increases (Boyle's Law).
- Reduction in bubble size may allow it to pass through the circulation.
- This effect is useful in the management of gas embolism and decompression sickness

Mass Action of Gases

- Flooding the body with oxygen forces the rapid elimination of other toxic gases such as carbon monoxide.
- The mechanic effect of increased pressure further accelerates the elimination process.

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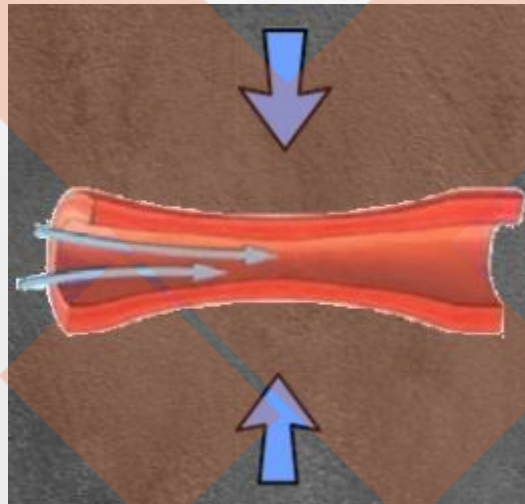
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Main Effects of HBOT

Vasoconstriction

- Vasoconstriction can result in reduction of edema.
- Even with reduced blood flow, enough extra oxygen is carried by the blood so a net increase in tissue oxygen delivery occurs with HBOT.
- This effect is therapeutic in crush injury/compartment syndrome and thermal burns.



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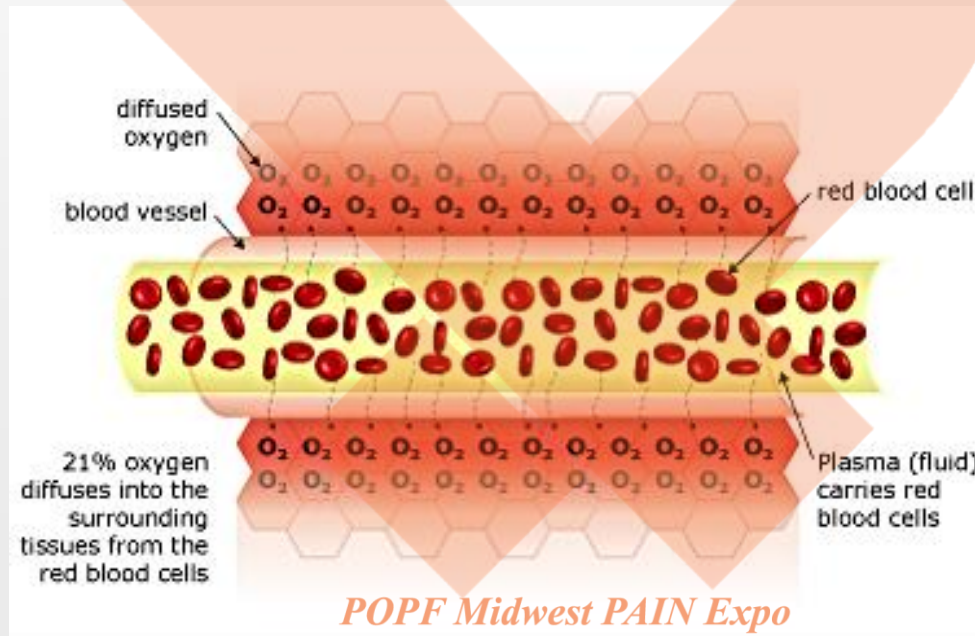
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Main Effects of HBOT

Hyperoxygenation

- HBOT physically dissolves extra oxygen into the plasma (Henry's Law).
- This effect increases delivery of oxygen to ischemic or underperfused tissues, which can limit ischemic damage, inflammation and cell death.
- The additional oxygen helps the ischemic tissue meet the increased metabolic needs of the healing process.



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Main Effects of HBOT

Antibacterial Effect

- Anaerobic bacteria do not flourish in the presence of oxygen.
- Many of the body's bacterial defense mechanisms are dependent on oxygen.
- HBOT slows the growth of anaerobic bacteria, allow the body's bacterial defense mechanisms to be reactivated, and combat clinical infections such as gas gangrene.

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Other Off-Label Uses of HBOT

There are clinical reports of HBO₂-induced therapeutic effects in the following conditions:

- Traumatic brain injury (TBI)
- Persistent post-concussion syndrome
- Cerebral palsy
- Multiple sclerosis
- Chronic fatigue syndrome
- Stroke
- Autism
- Cancer

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HBOT-Induced Pain Relief

There are clinical reports of HBO₂-induced relief of pain in the following conditions:

- Complex regional pain syndrome (reflex sympathetic dystrophy syndrome)
- Fibromyalgia
- Trigeminal neuralgia
- Migraine and cluster headache
- Rheumatoid arthritis
- Chronic osteomyelitis

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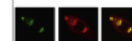
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Brain Research



Research Report

Involvement of brain opioid receptors in the anti-allodynic effect of hyperbaric oxygen in rats with sciatic nerve crush-induced neuropathic pain

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ARTICLE INFO

Article history:

Accepted 25 August 2013

Available online 30 August 2013

Keywords:

Hyperbaric oxygen

Anti-allodynia

Naltrexone

Opioid receptors

Neuropathic pain

Sciatic nerve crush

Rat

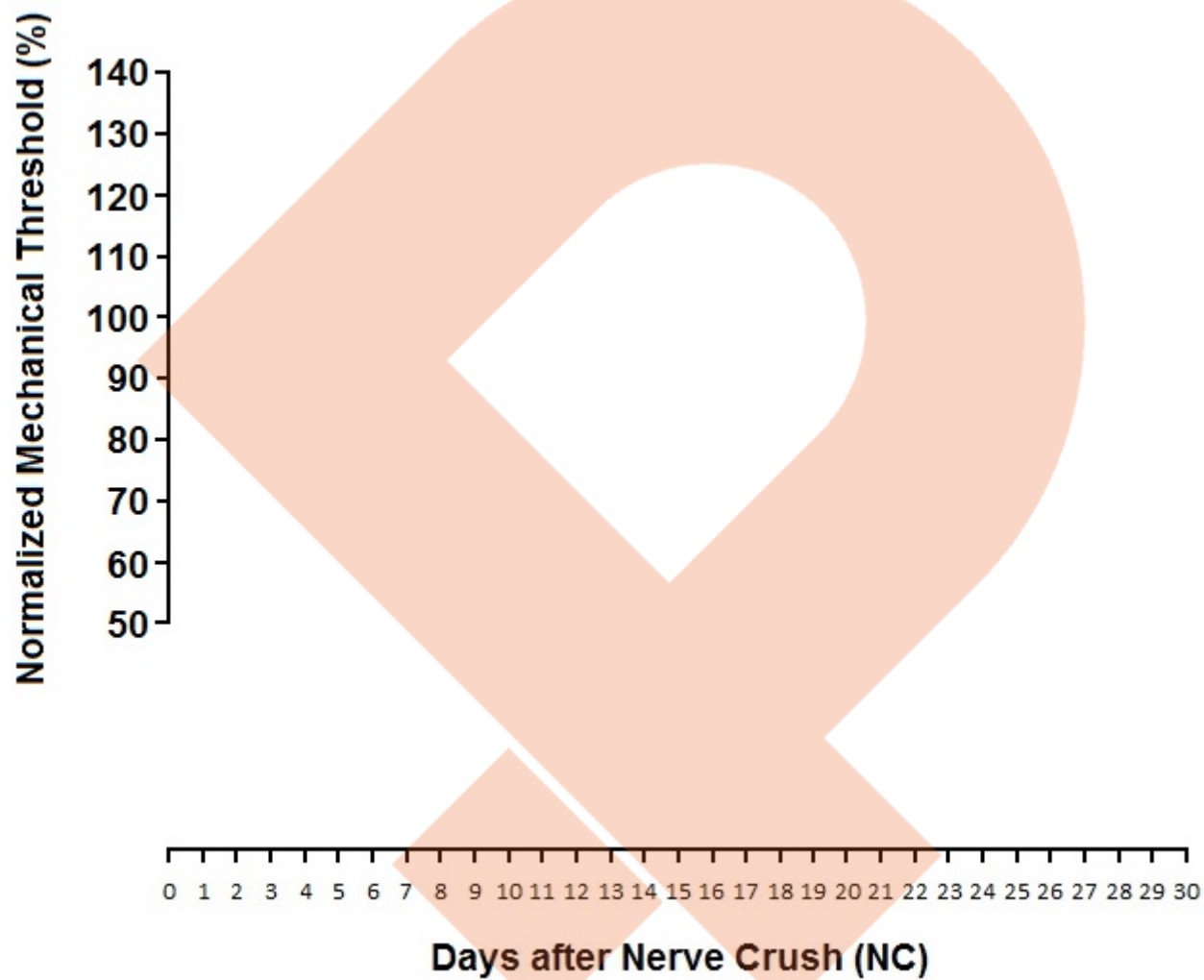
ABSTRACT

Earlier research has demonstrated that hyperbaric oxygen (HBO₂) can produce an antinociceptive effect in models of acute pain. Recent studies have revealed that HBO₂ can produce pain relief in animal models of chronic pain as well. The purpose of the present investigation was to ascertain whether HBO₂ treatment might suppress allodynia in rats with neuropathic pain and whether this effect might be blocked by the opioid antagonist naltrexone (NTX). Male Sprague Dawley rats were subjected to a sciatic nerve crush under anesthesia and mechanical thresholds were assessed using an electronic von Frey anesthesiometer. The time course of the HBO₂-induced anti-allodynic effect in different treatment groups was plotted, and the area-under-the-curve (AUC) was determined for each group. Seven days after the nerve crush procedure, rats were treated with HBO₂ at 3.5 atm absolute (ATA) for 60 min and exhibited an anti-allodynic effect, compared to nerve crush-only control rats. Twenty-four hours before HBO₂ treatment, another group of rats was implanted with Alzet[®] osmotic minipumps that continuously released NTX into the lateral cerebral ventricle for 7 days. These NTX-infused, HBO₂-treated rats exhibited an allodynic response comparable to that exhibited by rats receiving nerve crush only. Analysis of the AUC data showed that HBO₂ significantly reduced the nerve crush-induced allodynia; this anti-allodynic effect of HBO₂ was reversed by NTX. These results implicate opioid receptors in the pain relief induced by HBO₂.

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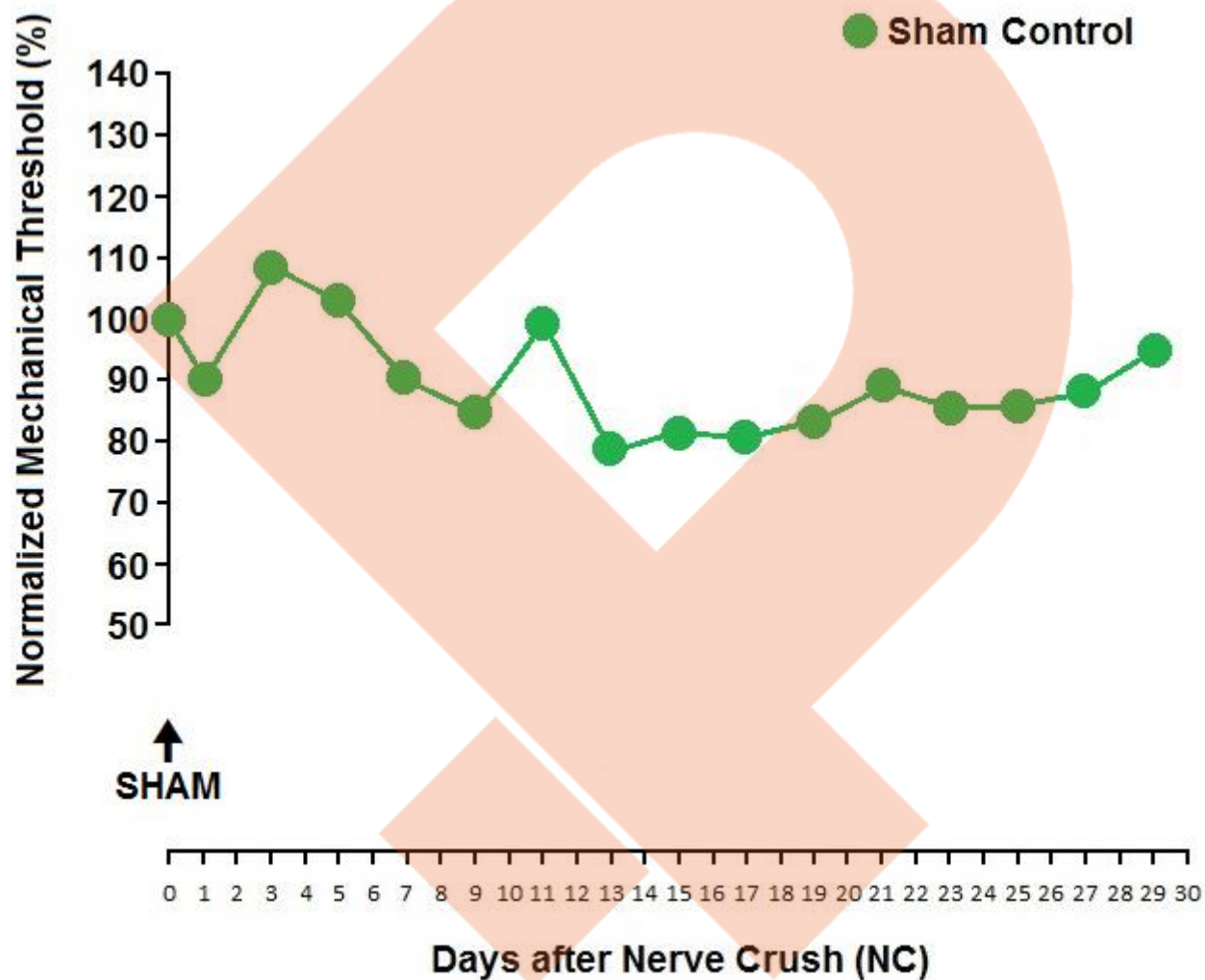
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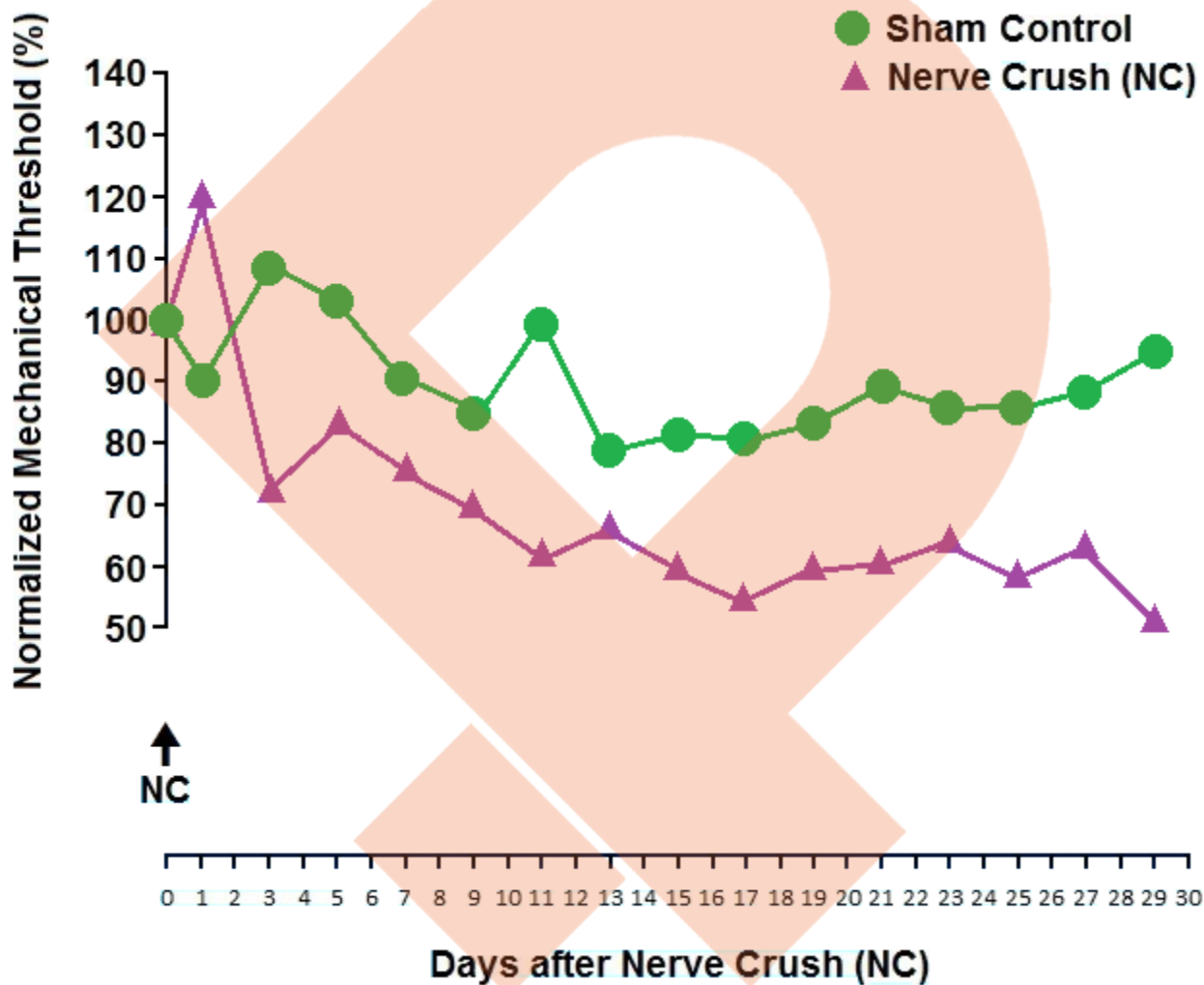
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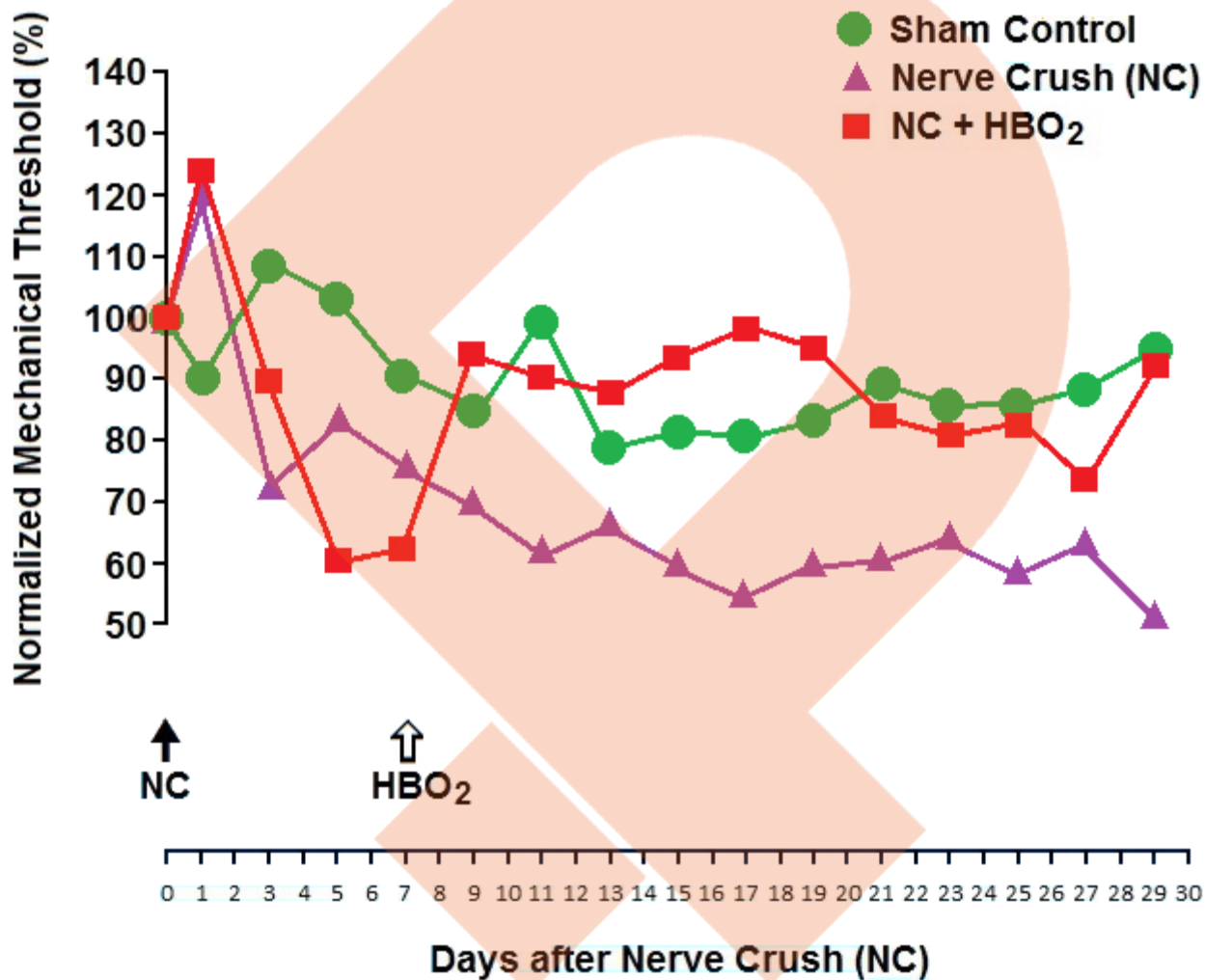
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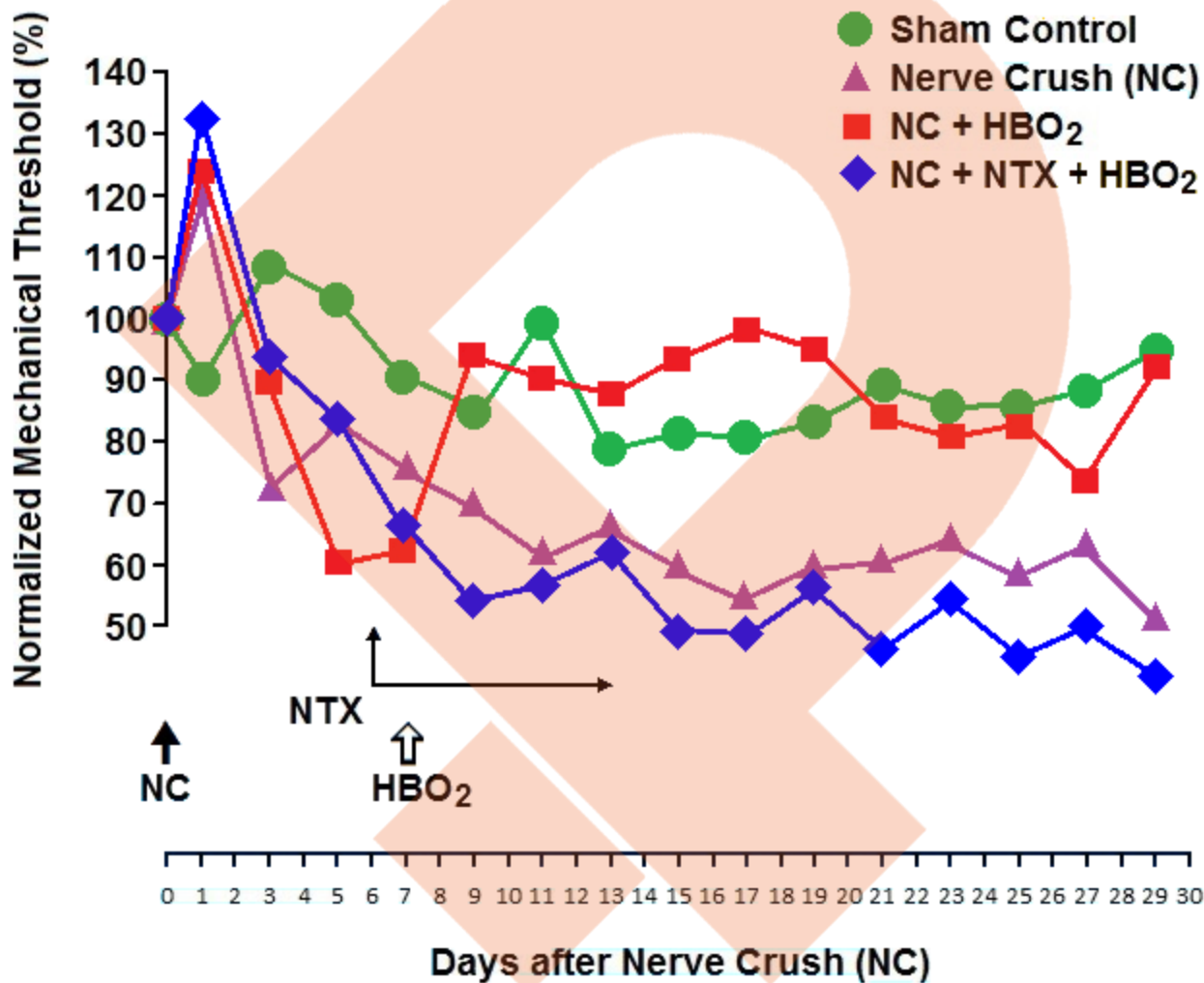
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Summary

1. HBOT is a medical treatment that delivers 100% oxygen under higher-than-normal atmospheric pressure.
2. There are fourteen clinical indications for HBOT in the U.S. that are approved by the AMA and the FDA.
3. There are several “off-label” indications that have been shown to be responsive to HBOT, including several conditions of chronic pain.
4. There are clinical reports that HBOT can produce pain relief in complex regional pain syndrome.
5. Basic science research indicates that HBOT-induced pain relief may originate from an action in the brain and possibly involve the endogenous opioid system.

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Acknowledgments



Yusuke Ohgami, Ph.D.

Eunhee Chung, Ph.D.

David W. Koh, Ph.D.

Yangmiao Zhang, Ph.D.

Shulin Liu, Ph.D.

Abigail Brewer

Jordan Nelson

Carlee Gibbons

Lindsay Quock

Lisa Zelinski



Donald Y. Shirachi, Ph.D.



Amber V. Buhler, Ph.D.



NIH grant GM-77153

NIH grant AT-007222

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