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# Interactive effects of acupuncture on pain and distress in major burns: An experiment with rats

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## ABSTRACT

This study sought to investigate the interactive effects of acupuncture on pain and distress and the local progress in the burn wound in an experimental major burn model. Forty-eight male Sprague-Dawley rats were divided into six groups: S group (sham/observation during 7 days after injury); SA group (sham/acupuncture/observation during 7 days after injury); B1 group (burns/observation during 1 h after injury); BA1 group (burns/acupuncture/observation during 1 h after injury); B7 group (burns/observation during 7 days after injury); and BA7 group (burns/acupuncture/observation during 7 days after injury). Pain and distress scores were evaluated throughout the study. The amounts of neutrophils and mononuclear cells were evaluated semiquantitatively, and the number of microvessels was evaluated quantitatively. Our data indicated that the average pain score of BA7 group was significantly lower than the other study groups. Histopathologic investigations indicate that the amounts of neutrophil and mononuclear cell and numbers of microvessels in the unburned skin were higher in acupuncture-applied groups. The number of microvessels in burn wounds of BA7 group was significantly higher than that of the other groups. Our data suggest that acupuncture provides low pain and distress scores in experimental rat model, and it contributes to wound healing with an enhanced angiogenesis during the acute phase of burns. Future clinical and experimental studies should be conducted to discern the benefits from acupuncture in pain management of burn patients.

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## 1. Introduction

Burn trauma induces mechanical and thermal hyperalgesia in human skin, resulting in a hypersensitive state that accompanies inflammation [1–3]. Clinical observations and research suggest that burn patients do not become habituated to pain, and strong correlations are found among pain, psychological

distress, and physiological outcomes in children and adults with burns [4]. In modern burn care, managing pain and anxiety is an indispensable component of burn treatment. Types of burn pain and anxiety are defined as *background pain*, *procedural pain*, and *breakthrough pain* [5].

All types of burn pain and anxiety result in psychological distress that causes a substantial delay in wound healing [6]. Stress-impaired wound healing is mediated primarily through

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the hypothalamic–pituitary–adrenal, sympathetic–adrenal–medullary axes [7,8].

For standard pain management, burn teams prefer to administer pharmacological agents such as opioids, ketamine, nonsteroidal anti-inflammatory agents, and sedatives. In addition to pharmacological therapies, nonpharmacologic analgesics (e.g., virtual reality analgesia) contribute to pain management during both the acute phase and the period following [9–11].

Acupuncture is a popular nonpharmacological therapy used for pain control. It also is widely used for various diseases. Numerous studies indicate that acupuncture is safe and effective in treating a range of disorders such as obesity, osteoarthritis, fibromyositis, trigeminal neuralgia, postoperative pain, and headache [12–17].

Current knowledge regarding the interactive effects of acupuncture on burn trauma is limited. Few studies have investigated the role of acupuncture on burn care. Some concern themselves with the effects of acupuncture on pain and stress control, while others concerned themselves with local wound healing [12,18,19]. Recently, the effects of acupuncture on burn wounds were investigated in an experimental rat burn model, but the study was concerned with wound healing rather than burn pain and distress. In previous experiments, acupuncture has been applied around the burn wounds (Ashi points), and the classic acupuncture points (e.g., Back-Shu points) have not been considered [18].

The effects of acupuncture application to Ashi points and Back-Shu points for different types of burn pain and distress in major burn trauma are unknown. Therefore, more-detailed and progressive studies are required that investigate the interactive effects of acupuncture for pain and anxiety control in major burns. The present experiment on rats investigates the interactive effects of acupuncture on pain and distress control and the local progress in the burn wound in an experimental major burn model.

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## 2. Materials and methods

Forty-eight male Sprague-Dawley rats weighing  $300 \pm 15$  g were obtained and housed in the Baškent University Laboratory Animal Center (temperature  $20 \pm 2$  °C, humidity  $50 \pm 10\%$ , and 12-h light/dark cycle). The animals were kept at standard conditions and fed standard rat chow and water ad libitum for at least 1 week before the experiments began. All animals received human care in compliance with the National Institute of Health Guide for the care and use of laboratory animals, and the study was approved by Baškent University Animal Care and Ethics Committee (DA: 13/56).

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### 3. Burn model

#### 3.1. Burn model creation

A preliminary study was performed on two male Sprague-Dawley rats before beginning research. The preliminary study sought to observe the appropriate brass plate temperature and contact time that would create deep partial-thickness burns

on the lower quadrants of the dorsa in the Sprague-Dawley rats. A 4-cm  $\times$  4-cm brass plate was used to induce burns. Temperature of the plate was monitored with a thermocouple device of a multimeter (Fluke 116 HVAC, Fluke South East Asia Pte Ltd, Singapore).

Rats were anesthetized with an intramuscular injection of 70 mg/kg ketamine hydrochloride (Alfamine 10%) and 7 mg/kg xylazine hydrochloride (Rompun 2%). The dorsa of the animals were shaved; burns were induced on the two lower quadrants of dorsa. The chosen temperature of brass plate for animal No. 1 was 200 °C, and it was 250 °C for animal No. 2. The contact periods were 5 s for the right lower quadrants and 10 s for the left lower quadrant. On histopathologic observation, the appropriate time for a deep partial-thickness burn wound was determined to be 5 s with a brass plate temperature of 250 °C.

#### 3.2. Burn induction and wound dressings in the present study

In this study, rats were anesthetized with an intramuscular injection of 70 mg/kg ketamine hydrochloride (Alfamine 10%) and 7 mg/kg xylazine hydrochloride (Rompun 2%). The dorsa of the animals were shaved; burns were induced on the right lower quadrant of dorsum with a 4-cm  $\times$  4-cm brass plate with a burn size covering approximately 30% of the total body surface area. For deep partial-thickness burn induction, the 4-cm  $\times$  4-cm brass plate was held in the flame of a Bunsen burner with full oxygen supply until the thermometer measured 255 °C. The brass plate lost 5 °C of heat until it was put on to the right lower quadrants. The plate was put against the prepared skin for 5 s. All animals were promptly resuscitated with lactated Ringer's solution (2 mL/100 g) intraperitoneally.

The thickness of each cutaneous burn wound was confirmed by histopathologic examination. Skin samples were burned down to the middle third zones of the dermis in the B1, BA1, B7, and BA7 groups.

For wound-dressing changes during the study period, the rats were anesthetized with an intramuscular injection of 70 mg/kg ketamine hydrochloride (Alfamine 10%) and 7 mg/kg xylazine hydrochloride (Rompun 2%). After application of silver sulfadiazine (Silverdin, Deva, Turkey), wounds were covered with superior film with acrylic adhesive (Opsites, Smith and Nephew, USA).

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## 4. Groups

#### 4.1. S (sham group)

In the S group, eight healthy rats were anesthetized with an intramuscular injection of 70 mg/kg ketamine hydrochloride (Alfamine 10%; Alfasan Inc, Woerden, The Netherlands) and 7 mg/kg xylazine hydrochloride (Rompun 2%, Bayer Kimya San. Ltd. Sti., Istanbul, Turkey). The dorsa of the animals were shaved. Twenty minutes after shaving, wound dressings were put onto the lower dorsum and initial blood samples were obtained. Lactated Ringer's solution (2 mL/100 g) was injected intraperitoneally. Wound dressings were changed every other

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