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Burn inducing device with temperature control to generate experimental cutaneous burn wounds in animal models

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Abstract

Extensive research is being carried out to replicate different aspects of burn injury, understand the unique pathophysiology as well as to develop novel treatment modalities for the burn wounds. Adequate research using different burn models thus play a major role in the development of novel treatments. One of the major constraints in burn animal model is a lack of reproducible burn inducing device which could be used for producing uniform burn wounds. Here we have developed simple, reproducible burn inducing device with temperature control for the creation of uniform burn wounds in animal models.

Keywords: *Burn, burn inducing device, burn models, uniform burn wound*

Burn is a serious public health concern which affects physical, psychological and social well-being of individuals. Burn wounds are different from other traumatic wounds in having a unique pathophysiology (Tiwari, 2012). Hypertrophic scarring, keloid, scar contractures are some of the unfavourable outcomes of burn wound. Extensive burn wounds produce systemic damage by evoking a hypermetabolic state and an intense inflammatory response that could lead to multi-organ failure. Burns have high susceptibility to infection as it produces vascular necrotic tissue and results in dampening of epidermal integrity (Tehrani *et al*., 2016). Extensive research is being carried out to replicate different aspects of burn injury, understand the unique pathophysiology as well as to develop novel treatment modalities for the burn wounds. The complex pathophysiological events associated with burn and the involvement of multiple organs make in-vitro experiments unreliable

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and have led to the development of number of burn animal model. Adequate research using different burn models thus play a major role in the development of novel treatments (Sayeed, 2005)

One of the major constraints in burn animal model is a lack of reproducible burn inducing device which can be used for producing uniform burn wounds (Shukla *et al.,* 2020). Several factors must be considered to produce uniform burns of same depth. Here we have developed simple, reproducible burn inducing device with temperature control for the creation burn wounds in animal models.

Materials and methods

Burn inducing device with temperature control consists of mainly three parts: 1. a temperature controlling system; 2. heat generating system; 3. metallic end block to inflict the burn (Fig. 1). Temperature controlling system consists of a micro controller-based processor-controlled thermostat system, a relay switch, and a thermal sensor. Heat generating system consists of a heating element made of nichrome which is enclosed in porcelain. Metal block used here is a square aluminium block of one-centimetre square area and weighing 50 g. Any desired temperature could be set using the

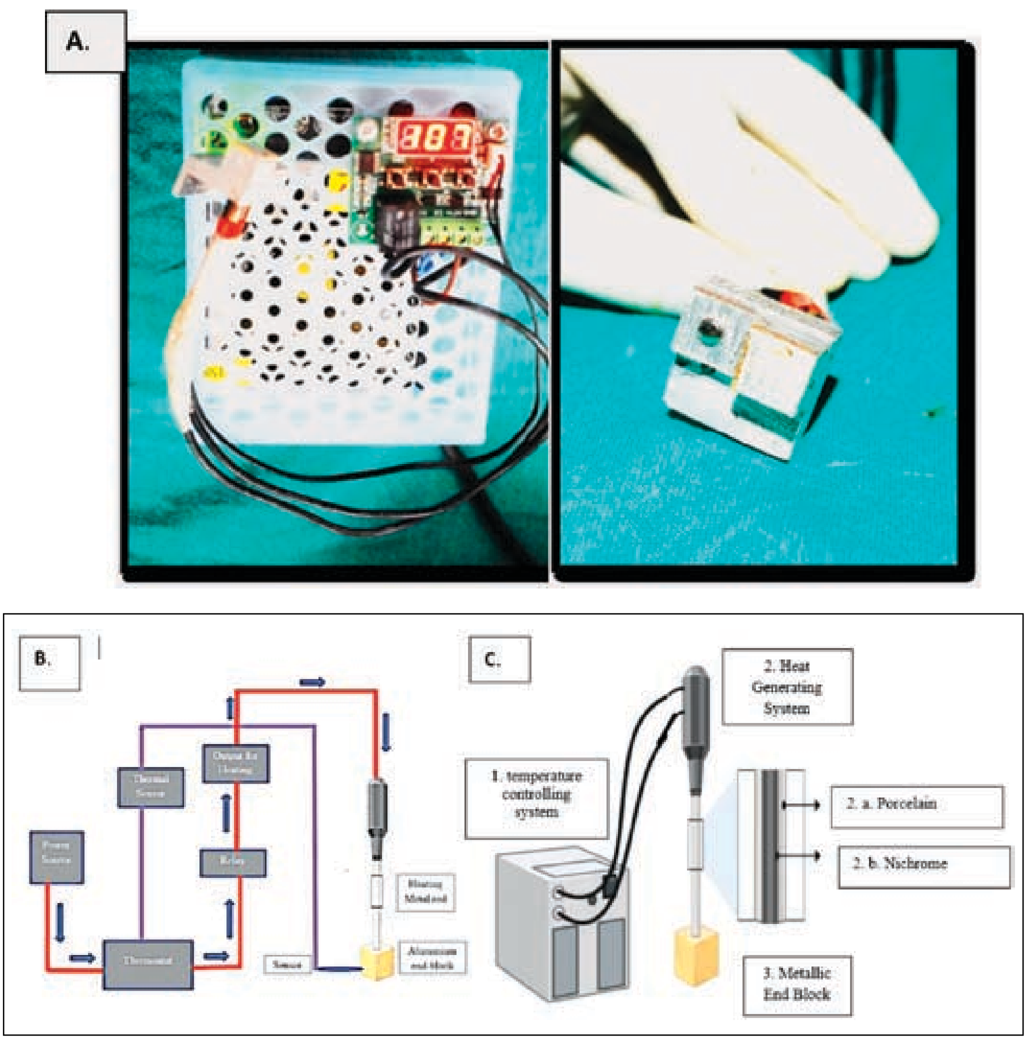

Fig. 1. **A.** Custom- made burn inducing device with temperature control
B. Schematic design diagram
C. Diagrammatic representation of parts of the device

control unit and the hot end would remain in the range of chosen temperature. The temperature dial is kept 7 degrees above the desired range taking into account of the temperature hysteresis range of the system which is +/- 7℃

Results and discussion

The burn wounds could be induced using this custom-made burn inducing device with temperature control by direct contact method. In the direct contact method, a heated metal instrument would be rested on the skin to inflict burn of desired area. This method is considered simple and safe for the investigator (Singer *et al.*, 2009). The temperature and duration of contact could be altered for producing burn wounds of different degrees.

The thermostat system detects the temperature of the hot end of the heating element using a negative temperature coefficient thermistor (sensor) which would enable the system to detect and control the heating element through a relay switch. The thermal sensor, included in the device would monitor the temperature of the aluminium end-block. This would help to maintain uniform temperature on the block throughout the procedure. The depth of the burn would be determined by the temperature of the material, contact time and the amount of pressure exerted by the investigator or the weight of the material used. Shape (square, circle) and size of the contact material would determine the shape and size of the injury (Mitsunaga *et al.*, 2012).

The heating element used for the device was nichrome. It is a family of alloys of nickel, chromium, and often iron, commonly used as resistance wire, heating elements in things like toasters and space heaters. It is a non-magnetic 80/20 alloy of nickel and chromium, is the most common resistance wire for heating purposes because it has a high resistivity and resistance to oxidation at high temperatures (Van Egmond, 1991).

The metal used for burn infliction can be stainless steel (Cai *et al*., 2014), brass or aluminium (Shukla, 2020). Aluminium was preferred for making the end block because of the high thermal conductivity and thus would help in rapid heat transfer (Abdeldjalil *et al.,* 2017). Metals with high thermal conductivity like brass could create a greater depth of burn compared to metals having lower thermal conductivity like stainless steel for the same time of contact (Cai *et al.*, 2014).

The temperature dial is kept 7 degrees above the desired temperature taking into account of the temperature hysteresis range of the system which is +/- 7 ℃. As the device heats up to the higher range, the aluminium hot end block will stay in the lower range due to excessive heat loss. Aluminium because of its high thermal conductivity can lose heat to the atmosphere and the temperature of the end block can go below the desired temperature if the procedure is delayed (Cai *et al.,* 2014). Thus, for compensating such a thermal loss, we have considered a temperature hysteresis range.

Conclusion

This device is a simple and reproducible one which could be used effectively for creating uniform cutaneous burn wounds in animal models. The depth of the burn can be altered by changing the temperature and duration of contact.

Conflict of interest

The authors declare that they have no conflict of interest.

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