Accidental Ear Burns Following Anaesthesia in Mice

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Summary
Homoeothermic heating systems are frequently used to prevent the occurrence of hypothermia during mice anaesthesia. The burn hazard is a relatively frequent but not well document post-operative situation in small animal practice. This paper reports a case of ear burns following anaesthesia in ICR (CD-1) mice.

Introduction
Hypothermia induced by anaesthesia may alter physiological processes, prolong recovery times, or even result in death (*Flecknell, 1996; Arras et al., 2001; Rembert et al., 2004*). Rodents are specially prone to suffer hypothermia because they have a large surface area relatively to their small body mass (*Flecknell, 1996*), which results in a rapid fall in core temperature during general anaesthesia. It is therefore recommended to use warming devices to prevent excessive heat loss during anaesthetic procedures.
The most commonly used warming devices in rodent practice are the circulating-water blankets, heat lamps and electric heating pads. It is generally recommended to avoid thermal injury and iatrogenic hyperthermia when using these devices *(Flecknell, 1996; Rembert et al., 2004*). The electric heating pads prevent the occurrence of hypothermia by providing a continuous source of heat placed below the animal. These devices are based in a feed-back control system. To maintain the desired internal temperature at a pre-set target value, a rectal temperature probe provides feedback to a controller about the animals´ core body temperature. The controller adjusts the current to the heating pad in order to maintain the desired body temperature.
Although the burn hazard is a relatively frequent peri-operative situation in small animal practice, there are no reports of similar situations in mice. This report describes the occurrence of ears burns in mice during anaesthesia. Animals with this pathology are likely to suffer a high degree of pain; a situation that may go undiagnosed, especially in dark animals.

Case Presentation
All procedures were carried out under personal and project licences approved by the national regulatory office (Direcção Geral de Veterinária - DGV). During routine no-treatment procedures, female ICR (CD-1, Harlan Iberica, Barcelona, Spain) mice were placed alone in an induction chamber with gas input and exhaust output lines. Anaesthesia was induced with 5% isoflurane in 100% oxygen with a delivery rate of 5 l/min until loss of righting reflex. After induction of anaesthesia, the animals were placed in dorsal recumbence on a homeothermic blanket (N-HB101-S-402, Panlab, Spain) and temperature was kept between 36-38ºC. Anaesthesia was maintained with 1,5% isoflurane in 100% oxygen with a flux of 1.5 l/min administered by a co-axial circuit . The procedures were all carried out in the same day and each anaesthesia lasted 30 minutes.
Twenty four hours later at clinical examination several mice showed clinical symptoms of ear burns.

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The animals were euthanized by intraperitoneal administration of sodium pentobarbital (Eutasil®, Sanofi Veterinária, Algés, Portugal) and necropsies were performed.

Results

On gross examination full-thickness burns were charred or whitish and dry, whereas partial thickness burns were pink or mottled with blisters (Fig 1). Most of the animals presented lesions in both ears. On histological examination, partial thickness burns presented blisters, hyperemia, and oedema as the most prominent features (Fig 2A). The deeper portions of the dermal appendages were spared (first and second degree burns). Full-thickness burns were characterized by total destruction of the epidermis and dermis, with loss of dermal appendages (third and fourth degree burns). Devitalized tissue

Figure 1. Animal with severe tissue loss and full-thickness burns in both ears.

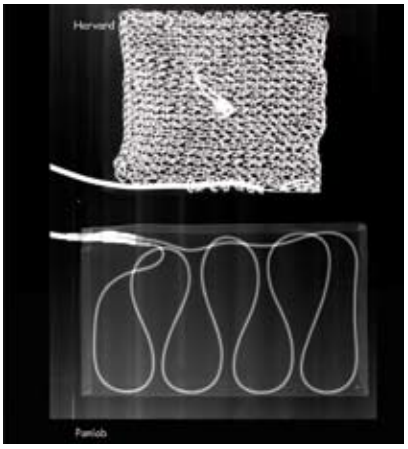

Figure 3. Radiograph of the used homeothermic blanket (N-HB101-S-402, Panlab, Barcelona, Spain) (below) and Harvard blanket (Harvard Apparatus , Massachusetts, USA) (above)

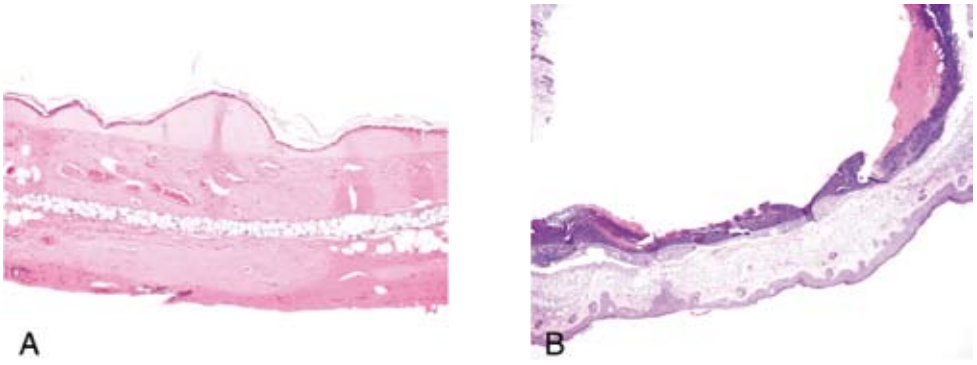

Figure 2. Blister formation and oedema accompanied by coagulative necrosis of the dermis (A). Epidermal and dermal necrosis accompanied with tissue loss, and extensive cellular debris in the dorsal surface of the ear. The ventral surface shows accumulation of inflammatory cells (B). Original magnification A:100x; B: 40x.

demonstrated coagulative necrosis, and the adjacent vital tissue developed inflammatory changes with an accumulation of inflammatory cells and marked fibrin exudation (Fig 2B).

A digital radiograph (using a Fujifilm FCR-XG-1 processor and Innovet® V125 x-ray equipment) of the used blanket (HB101-S-402, Panlab, Barcelona, Spain) was taken side by side with another blanket from our laboratory (Harvard Apparatus, Massachusetts, USA), which did not cause the described lesions under the same circumstances and during similar procedures (Fig. 3).

Discussion

This paper reports a case of ear burns following anaesthesia in ICR (CD-1) mice. Animals with this pathology are likely to suffer a high degree of pain. This situation if not recognized may have serious implications over the refinement of the procedure, one of the "Three Rs" of animal usage. Previous studies have showed measurable differences induced by various handling and lifting methods in rats (*Baturaite Z et al., 2005*). A higher variation is expected in animals suffering from pain.

During anaesthesia, the temperature in small animals can easily drop to values below 37-38ºC. Manual control of temperature has been replaced by automatic devices. These devices are intended to maintain the animals´ body temperature at a value previously selected by the anaesthetist. In the radiograph taken, it is noticed that the two devices have very different heating resistance distributions. It is probable that the first (Panlab) device used could not maintain a homogeneous temperature throughout the blanket. The areas directly above the electric resistances in the Panlab blanket may have much higher temperatures than the adjacent ones. A diffused and uniform distribution of the heat is very important to ensure the safety of the device. This may be achieved with a more uniform distribution of the electrical resistances throughout the blanket, forming a more uniform pattern as we can see in the Harvard blanket radiograph.

These findings highlight the necessity for proper insulation between the heating blanket and the animal. In mice, special attention should be dedicated to the thickness of this insulation layer, allowing a better heating spread and a more homogenous heating distribution to avoid overheating the animal.

There are few published temperature control studies in rodents. The forced-air warmer blankets have been studied for their applicability in warming procedural areas and cages during recovery (*Rembert et al., 2004*). These systems seem to be an effective method to quickly warm rodent procedural areas, with a minimal risk of thermal injury. New developments on blankets to be applied to rodents, and research evaluating the effect on body temperature of these thermal support methods, should be helpful in the search for better alternatives to the traditionally applied techniques.

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