Hair cortisol concentrations in New Zealand white rabbits subjected to surgery

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Abstract

The aim of this study was to assess hair cortisol concentrations in New Zealand white rabbits (Oryctolagus cuniculus) that were subjected to relocation and surgery to evaluate HPA-axis activity; in addition, we used this marker of cortisol secretion to evaluate the allostatic load of animals undergoing surgery. After a period of acclimatisation, which lasted 40 days from their arrival at the enclosure, 19 rabbits were subjected to T1–T12 dorsal arthrodesis (RS), 19 were sham-operated (SS), and 19 were non-operated (CON). Hair samples were collected at the time of arrival (ST1) at the animal facility, and seven other sets of hair samples were collected at 40-day intervals from the same area of skin for a period of 240 days as re-shaved hair (anagen phase): immediately before surgery (ST2) and after the surgery (ST3, ST4, ST5, ST6, ST7, and ST8). The transition from the rabbitry to the animal breeding facility led to a significant increase in cortisol concentration (ST2) in all of the groups. At ST3, the RS group presented higher cortisol concentrations than those of the SS group and the CON group. At ST4, the experimental groups showed similar values that remained constant until ST8. The results show that the management of rabbits undergoing surgery should be evaluated very carefully, and hair cortisol concentrations may provide a means of avoiding the dangerous cumulative effects of additional stressors close to surgery.

Keywords: animal welfare, cortisol, hair, HPA axis, rabbit, surgery

Introduction

Cortisol is involved in metabolic homeostasis and the regulation of many physiological processes. It is the end-product of HPA-axis stimulation and is the primary glucocorticoid in most mammalian species, whereas in rodents, birds and reptiles corticosterone is the primary glucocorticoid. Rabbits secrete both corticosterone and cortisol in a circadian rhythm. Szeto et al (2004) found that the values of both glucocorticoids were significantly correlated, suggesting that these hormones are regulated in a similar fashion and exhibit similar response profiles. Cortisol can be measured in the blood or, non-invasively, in faeces (Teskey-Gerstl et al 2000), urine (Walker et al 2009), milk (Gygax et al 2006) and saliva (Negrao et al 2004). These methods provide a measurement of the cortisol concentration either at a single point in time or within the previous 12–24 h (Russell et al 2012). Cortisol concentrations in hair provide an integrated rather than a single-time-point measure of HPA-axis activity (Meyer & Novak 2012). The collection of hair is simple and non-invasive. Furthermore, hair samples do not decompose as body fluids or other tissues (Balikova 2005). The precise mechanisms by which lipophilic steroid hormones are incorporated into hair are still not fully understood. There are studies to support both a systemic and a local derivation. It is known that brain and skin communicate with each other (Zmijewski & Slominski 2011; Chen & Lyga 2014) to regulate global homeostasis through the systemic release and/or local production of hormones, neuropeptides, neurotransmitters and biological regulators (Slominski & Wortsman 2000; Slominski 2005; Zmijewski & Slominski 2011). Hair follicles, being surrounded by a dense and continuous plexus of capillaries (Montagna & Ellis 1958) and as one of the most densely and intricately innervated of all peripheral tissues (Paus & Fötzik 2004), are an ideal model to study the inter-system communication characteristic of stress responses. The presence of several neuropeptides and other biologically active compounds in the skin and its appendages is due to the transport of them from blood, to the release of them from nerve-endings or to the migrating immune cells but also to their local synthesis (Slominski & Wortsman 2000; Slominski 2005; Zmijewski & Slominski 2011) since the skin expresses an equivalent of the HPA axis (Slominski & Mihm 1996). A possible supply in the hair due to local cortisol production has been described in vitro (Ito et al 2005; Slominski et al 2007; Russell et al 2014) or in vivo as a consequence of a local stimulation (Sharpley et al 2009, 2010; Stubbsjoen et al 2015; Salaberger et al 2016). Other studies provide support for the systemic model...