Evaluation of microwave energy as a humane stunning technique based on electroencephalography (EEG) of anaesthetised cattle

J-L Rault*, PH Hemsworth†, PL Cakebread‡, DJ Mellor‡ and CB Johnson‡

1 Animal Welfare Science Centre, School of Land and Environment, University of Melbourne, Melbourne, VIC 3010, Australia
2 Animal Welfare Science and Bioethics Centre, Institute of Veterinary, Animal and Biomedical Sciences, Massey University, Private Bag 11222, Palmerston North, New Zealand
* Contact for correspondence and requests for reprints: raultj@unimelb.edu.au

Abstract

Humane slaughter implies that an animal experiences minimal pain and distress before it is killed. Stunning is commonly used to induce insensibility but can lead to variable results or be considered unsatisfactory by some religious groups. Microwave energy can induce insensibility in rats, and high power equipment has recently been developed for sheep and cattle. We examined the effectiveness of different settings for microwave energy delivery, power and duration, to induce insensibility based on electroencephalography (EEG) of anaesthetised cows, using the minimal anaesthesia model. All applications resulted in the appearance of seizure-like complexes in the EEG, a pattern considered incompatible with awareness. Shorter duration of application resulted in more rapid EEG changes, as quickly as 3 s. Higher power resulted in a longer duration of EEG suppression, at least 37 s and up to 162 s. Microwave energy can induce insensibility in cattle based on seizure-like complexes in the EEG.

Keywords: animal welfare, electromagnetic, euthanasia, insensibility, pre-slaughter, slaughter

Introduction

Humane slaughter implies minimal pain and distress on an animal before it is killed. Various factors can influence pain, fear and distress in abattoir settings including: the previous experience and breed of the animal (Grandin 1997); the facilities’ design (Grandin 1990); handling techniques (Hemsworth et al 2011); and the stunning method used (Anil 2012). In Western countries, stunning of the animal is a legislative requirement mandated to induce insensibility, defined as the incapability to experience any feeling or sensory experiences, and thus ensure that the animal cannot feel pain. Different stunning techniques can be used depending on factors such as the species and age of the animal, practicality, animal and worker safety and economical considerations (AMI 2010; Anil 2012). Some stunning techniques qualify as reversible, with the animal able to recover from the process (eg head-only electrical stun), whereas others are irreversible if performed correctly (eg captive-bolt stun). However, current stunning techniques can lead to variable results (captive-bolt stunning: Gouveia et al [2009] with efficiency of 68.2%; electrical stunning: Zivotofsky & Strous [2012] reporting efficiencies of 60.9 to 90%), hence the search for novel stunning techniques or alternatives.

The current standards around slaughter in Australia (AS 4696: 2007, sub-clause 7.10; Anonymous 2007) and the United States (Humane Methods of Slaughter Act of 1978) for instance require that an animal is rendered unconscious and insensible to pain prior to slaughter and remains so until death. However, Halal and Kosher meat production requires that animals being processed for human consumption are healthy and uninjured at the time of slaughter. Consequently, many of the methods of stunning used in modern commercial abattoirs are not acceptable as the animals are considered injured by the stunning process and the animals cannot recover from stunning (Nakyinsige et al 2013). As a result, ‘ritual slaughter’ without prior stunning is enabled in Australia (AS 4696: 2007; sub-clause 7.12) and the United States (Humane Methods of Slaughter Act of 1978; Section 6).

The pain that an animal experiences at slaughter is central to the legislative requirement to stun in Western countries. Pain is difficult to study because it is an inherently subjective experience. While humans can report pain, only indirect indices of pain are available for use in animals. Furthermore, many of the traditional behavioural and physiological indices that have been used to study pain are also measures of non-painful stressors. For example, measures such as hormone response (eg catecholamines, glucocorticoids) and behaviour are not specific to pain (Mellor et al 2000). However, neurophysiological tools are now widely used in humans to assess pain. Studies in humans experiencing pain have demonstrated that in contrast to the more traditional physiological measures, electroencephalographic (EEG) data correlate well with subjective evaluations of pain, indicating the value of quantitative EEG analysis as an