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Original Scientific Article

POST-MORTEM DECREASE IN TEMPERATURE IN THE ORBIT OF DOGS FOR USE IN DETERMINING TIME OF DEATH

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Summary: Determination of time of death is a complex process taking into account numerous biological and environmental factors. These have to do with the changes taking place in the body immediately after death, mainly rigor mortis, lividity and the decrease in body temperature with the passage of time in specific ambient temperature and humidity conditions. Until recently body temperature was measured only in the rectum because the mechanisms of heat loss had been precisely established. Currently body temperature is measured in other tissues as well, including the soft tissues of the orbit.
The aim of this study was to evaluate the suitability of post-mortem measurement of the decrease in temperature in the orbit for determining the time of death of an animal (a dog) while taking into account the dynamics of changes in temperature measured in the rectum.
The carcasses of twenty dogs were examined. The temperature in the orbit and rectum was measured every half hour for 12 hours from the time of death. The body mass of the dog was found to affect the rate of the decrease in temperature in the orbital soft tissues. Because the dynamics of changes (decrease) in temperature in the orbit and rectum were uniform, temperature measurement at this site may be a valuable alternative method for determining time of death. Slight changes in ambient temperature and humidity did not affect the rate of cooling of the body.

Keywords: time of death; cooling of the body; temperature in the orbit; rectal temperature

Introduction

Precise determination of the time passed since the moment of death in humans or animals constitutes fundamental information allowing investigators to narrow a field of suspects and verify their alibis. Estimating the time of death as accurately as possible is the task of the expert physician examining the body. There are several more or less accurate methods for determining time of death, the most common of which is evaluation of the dynamics of post-mortem changes, particularly changes in rectal temperature. However, these analyses become less precise as time passes after the moment of death. For this reason attempts are made to develop a new, objective method enabling more precise determination of the time of death of an animal in the initial period after its death. This problem led the authors to attempt to use temperature measurement in forensic veterinary practice.

Due to the large number of cases in which animals are victims at the site of a crime, it is increasingly often necessary to determine the time of their death (1,2). When the time of death of an

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animal cannot be definitively determined on the basis of medical history, it is necessary to observe changes in the parameters of signs of death and to determine their dynamics. In forensic veterinary practice time of death is determined using methods based on evaluation of postmortem changes and measurements of the internal temperature of the animals. The measurements are most often made in the rectum, and this is currently one of the most objective methods for determining time of death (3,4,5).

Analysis of the available literature shows that only a few studies provide information concerning the practical use of the orbits as sites for measuring temperature with the purpose of determining time of death (6,7). For this reason we have chosen to attempt to develop a new method for use in forensic veterinary medicine enabling precise determination of time of death in the initial period after the death of an animal.

Attempts to determine time of death in humans on the basis of changes in body temperature date back to the mid-19th century, but the greatest progress was made at the end of the 1980s, when Henssge and colleagues developed nomograms making it possible to read off the time passed since the death of the individual. The proposed method takes into account the rectal temperature, the ambient temperature and the weight of the body (8, 9). Currently the achievements of Henssge and other researchers are exploited by computer programs, which has made it considerably easier to determine the moment of death (10,11).

Examinations were initially carried out by measuring the temperature in the rectum, but currently measurements made in other organs are used as well, such as the liver, the brain, and the vitreous humour of the eye (12).

The aim of the study was to evaluate the suitability of post-mortem testing of the decrease in temperature in the orbital soft tissues in comparison with rectal temperature in dogs in conditions of relatively constant air temperature and humidity.

Material and methods

The carcasses of twenty dogs aged 7 to 16 years were examined. The body mass of the dogs ranged from 4.5 to 48 kg. The animals were divided into two weight groups. The first group consisted of eleven small dogs (with body mass up to 12 kg) and the second consisted of nine large dogs (with body mass over 12 kg). The animals had been euthanized due to advanced age-related health problems or generalized cancer. All animals used in the study did not have damaged integument and were covered by short-hair coat. Only cases in which the time of death could be precisely and unquestionably determined on the basis of medical history were included in the study. The dogs' owners consented to the use of the carcasses as research material.

The carcasses were stored in a room in which the temperature, humidity and air flow were continuously measured. The results were recorded every 10 min using an anemometer (Airflow TA-440A). The physical parameters of the air, which were constant over the entire study period, were as follows: temperature 18°C, relative humidity 65% and mean air flow 0.1 m/s.

The temperature in the orbit and rectum was measured every half hour for 12 hours from the time of death. A needle probe was inserted into the orbital soft tissue in the vicinity of the medial canthus, moving along the medial rectus muscle towards the superior orbital fissure to a depth of 25 mm. A measuring probe was inserted into the rectum to a depth of 40 mm. The first measurement of internal temperature was made when the animal was euthanized. Temperature was measured with a TERMIO-25P electronic thermometer with accuracy of ± 0.01°C in conjunction with a 4 mm x 120 mm ST-02 temperature probe (Termoprodukt, Poland).

The data were analyzed with the use of statistical package SPSS 20.0PL (13). The t-test for independent variables and one-way ANOVA with Duncan's post-hoc test was carried out.

Results

The mean temperature measured in the orbit and the rectum in each time interval in the small and large dogs (Fig. 1) shows a gradual decrease over time. At the time of euthanasia the mean orbit temperature in the dogs was 38.34°C and the mean rectal temperature was 38.47°C. Statistical differences caused by body mass of dogs were not statistically confirmed.

The results of the measurements in the rectum and orbit show that the mean temperature in the large dogs was higher than in the small dogs in

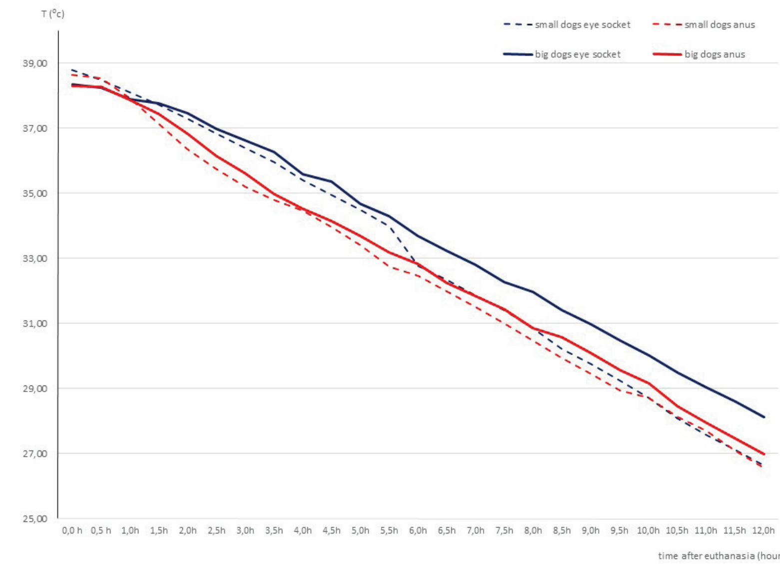

Figure 1: Mean rectal and eye socket temperature in the groups of small and large dogs

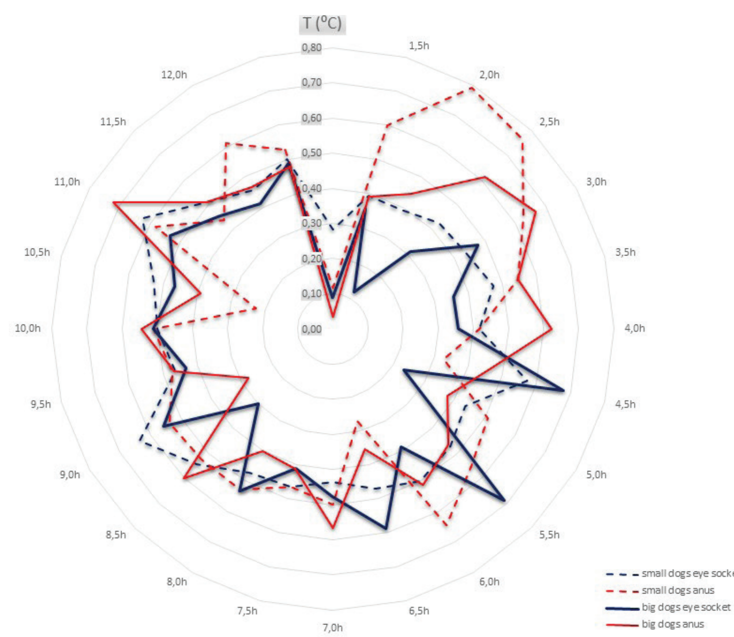

Figure 2: Difference in rectal and eye socket temperatures in the groups of small and large dogs at 30-minute intervals

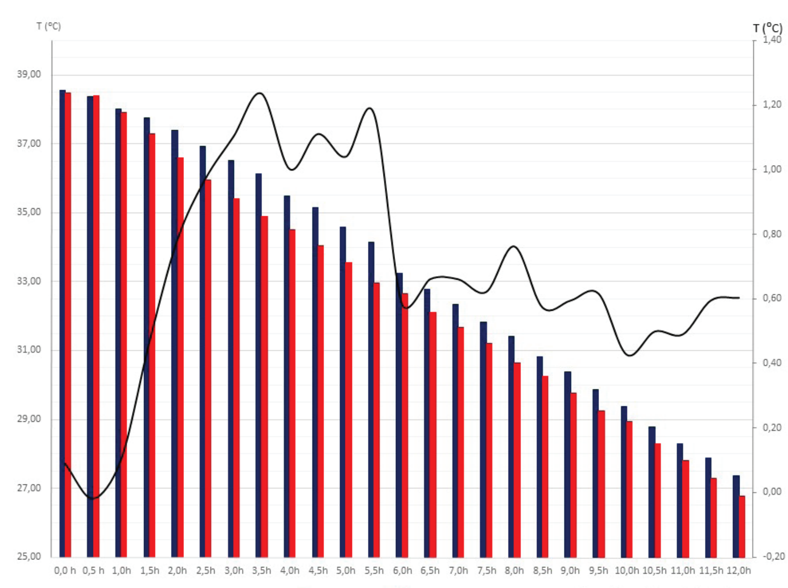

Figure 3: Mean temperature and differences in temperature between the eye socket and rectum

each time interval. At the same time the decrease in temperature in the orbit was slower than in the rectum, irrespective of the size of the dog (Fig. 1). The dynamics of temperature changes were more uniform in the orbit than in the rectum. Additionally, between 2nd and 4th hour after euthanasia in big dogs' group statistically sigificant difference was stated between mean value of temperature in eye and anus.

A comparative analysis was also made between the mean differences in temperature in the orbit Te and in the rectum Ta in the small and large dogs (Fig. 2). Greater temperature amplitude was noted for the rectum in the small and large dogs. The greatest difference in temperature, about 1.0°C, was noted in the rectum of small dogs between the first and third hour after death.

The dynamics of the decrease in temperature in the orbit and rectum were also analysed for both mass groups combined in the time intervals studied (Fig. 3). In the first two hours the difference in temperature between the orbit and the rectum did not exceed 1.0°C. Between 3 and 6 hours after death the difference in temperature between the two sites was highest, exceeding 1.2°C.

Discussion

The dynamics of the temperature changes in the orbit were more uniform than in the rectum, and the external atmospheric conditions had no effect on these changes. The results confirm the validity of using orbital soft tissues as a site for measuring temperature in the early period after death. A significant factor in support of this method is the lack of relationship between the rate of cooling in the orbit and body mass, as in the case of standard methods.

A similar conclusion was reached by Kaliszan & Hauser (6), who carried out research using the eyeball and orbital soft tissues of pig carcasses. They showed that the temperature of the eyeball decreases much faster than in the rectum, and observed no plateau effect (a stage in which the decrease in temperature is delayed in the initial post-mortem cooling period), which significantly distorted estimates based on measurements of rectal temperature. According to the authors, an additional argument in favour of using eyeballs and orbital soft tissues as sites for measuring the decrease in temperature in order to determine approximate time of death is the anatomical structure of these sites and the homogeneity of their localization between individuals on the cooling process. They also observed that low air movement (about 2 on the Beaufort scale) in the room where the measurements were made had no significant effect on the rate of cooling of the body.

In subsequent years Kaliszan (7) conducted a study enabling the use of a formula for estimation of the time of death based on temperature measurements in the human eyeball, developed on the basis of earlier comprehensive research on pigs. The possibility of using this method and its reliability can be explained by the similar anatomical structure and location of these organs in humans and pigs, and therefore presumably similar thermodynamic properties in these mammalian species. The author presented three cases in which measurements were made of the internal temperature of the eyeball shortly after death, at the site of the incident, and in this manner the time of death was precisely determined. The estimated time of death was confirmed during a police investigation.

The results obtained by Kaliszan (7) show that the method of determining time of death on the basis of post-mortem temperature measurements in the eyeball is sufficiently accurate in the early period after death, particularly when the body is situated in a relatively constant room temperature and in optimal atmospheric conditions (normal humidity and low air movement). According to the author, an additional argument in favour of the use of this means of temperature measurement is the way in which special touch probes are placed on the surface of the eyeball. This makes it possible to avoid the risk of damage to the rectum, particularly in cases of sexual assault. He also observed that the results of research carried out in pigs may enable more precise determination of the rate of cooling specific to the human eyeball, which could make the method even more precise.

Proctor et al. (14) also conducted a study using temperature measurements of dog carcasses to determine time of death. The analyses were carried out using the liver, brain, ear canal and rectum as sites for measuring the decrease in temperature. The study was conducted in a room in which the temperature was close to room temperature and the air movement was barely perceptible. They observed that sex and coat thickness had no effect on the rate of decrease in body temperature, but greater body weight and volume slowed down the process. They were unable to definitively determine which of the measurement sites was most reliable in dead dogs on the basis of their study, but Al-Alousi et al. (15), after observing temperature changes in human organs, suggested that the most objective measurement site is the brain, followed by the liver, rectum and ear canal, in that order. According to Marcinkowski (16), rectal temperature decreases by 1°C per hour for 6 – 9 hours, but the plateau effect, when the decrease is very small, should be considered. This state continues until about 3 hours after death. In the following hours the decrease in temperature is slower and less regular than in the initial period (6, 7, 17). Moreover, in the last three decades veterinary forensic medicine has advanced and many studies have been conducted on dogs, pigs and deer (15, 18, 19, 20).

Introducing post-mortem measurement of the temperature of orbital soft tissues to forensic veterinary practice for the purpose of determining time of death in the initial period may lead to more precise estimates.

In conclusion, the decrease in temperature in the orbital soft tissues and rectum was uniform, so it enabling more precise determination of time of death. The body mass of the dogs affected the rate of cooling in the rectum and the orbital tissues. Measurements of the temperature of the orbital soft tissues may become a valuable method for determining time of death in dogs, and the use of this site is justified up to about 12 hours after death. The research should be continued in order to develop a mathematical model enabling determination of the time passed from the death of the animal to the discovery of the carcass. Because the dynamics of changes (decrease) in temperature in the orbit and rectum were uniform, temperature measurement at this site may be a valuable alternative method for determining time of death. Slight changes in ambient temperature and humidity did not affect the rate of cooling of the body.

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ZMANJŠANJE TEMPERATURE V OČNICI PSOV PO SMRTI KOT MOŽNOST ZA DOLOČANJE ČASA SMRTI

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Povzetek: Določanje časa smrti je kompleksen proces, pri katerem je potrebno upoštevati številne biološke in okoljske dejavnike. Ti vplivajo na spremembe, ki se dogajajo v telesu takoj po smrti, predvsem na mrtvaško otrplost, modrikavost in znižanje telesne temperature, ki so vse pogojene s časom ter pogoji okolja, kot so temperatura in vlažnost. Do nedavnega se je telesna temperatura merila le v danki, kjer je mehanizem toplotnih izgub natančno določen. Danes se telesna temperatura meri tudi v drugih tkivih, vključno z mehkimi tkivi očnice.

Cilj te raziskave je bil oceniti ustreznost merjenja znižanja temperature v očnici po smrti z namenom, da se določi čas smrti živali (pes), pri čemer se upošteva dinamika sprememb temperature, izmerjene v danki.

Pregledana so bila trupla dvajsetih psov. Temperatura v očnici in danki je bila izmerjena vsake pol ure do 12 ur po smrti. Ugotovljeno je bilo, da telesna masa psov vpliva na stopnjo znižanja temperature mehkih tkiv očnice. Ker so spremembe (znižanje) temperature v očnici in danki enake, je lahko merjenje temperature na tem mestu dragocena dodatna metoda za določanje časa smrti. Majhne spremembe v temperaturi okolja in vlažnosti niso vplivale na stopnjo hlajenja telesa.

Ključne besede: čas smrti; ohlajanje telesa; temperatura v očnici; rektalna temperatura