Using telemetry to measure chicken embryo temperature: developing the technique

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To determine embryo temperature under natural conditions, it would be useful to determine this temperature without potential disturbing factors. Therefore, a telemetric system to determine embryo temperature is possibly preferable above a system in which thermistors are connected with cables to a data logger. In an experiment the optimal location and day of implantation of a temperature transponder in the egg was determined. Small temperature transponders were implanted at day 1 or 7 of incubation in either the air cell, albumen, or yolk. Implantation of the transponder in the yolk at day 1 or 7 and in the air cell at day 1 resulted in a really low survival rate. Implantation in the albumen or in the air cell at day 7 had minor effect on embryo mortality and development. In a second experiment, the effect of day of implantation in the air cell was investigated more into detail. It was shown that implantation of a temperature transponder at day 3 of incubation or later did not affect embryo mortality, but it seemed that embryo weight remained lower when the temperature transponders were implanted in early incubation. The embryo temperature could be measured very well outside the egg. We concluded that implantation of telemetric temperature transponders in eggs is possible, but not at all sites and all days of incubation. Whether this method is useful to determine embryo temperature under natural brooding conditions, needs to be investigated further.

Keywords: incubation; temperature; technique, embryo, egg temperature

Introduction

To optimize artificial incubation conditions, it can be useful to study natural brooding conditions. In chickens, during a 21-days incubation period, the conditions are not always the same for the embryo; the hen is leaving the nest, weather conditions vary and embryonic heat production is increasing throughout incubation (Romanoff, 1967; Janke et al., 2004; Lourens et al., 2006a). What the consequences of these circumstances are for the developing embryo is unclear. Therefore, it would be helpful to determine embryo temperature. This can be done by small thermistors or thermocouples attached to the eggshell (Van Brecht et al., 2005; Lourens et al., 2006a) or implanted in the allantoic fluid (Holland et al., 1998; Janke et al., 2004) or somewhere else in the egg (Sotherland et al., 1987; Tazawa and Rahn, 1987; Turner, 1990; Ono et al., 1994). These thermistors or thermocouples are connected to a data logger to determine the embryo temperature continuously. However, this connection possibly limits the hen to turn the eggs, without disturbing the embryo. Therefore, a telemetric system to determine embryo temperature on distance can help to overcome this problem. Aim of this experiment was to determine the optimal location and day for implantation of temperature transponders in the incubated egg.

Materials and Methods

Eggs of commercial broiler breeders were used. Average egg weight at moment of implantation was 68.4 g (SD=4.6). Temperature transponders (2 x 11 mm; BMDS, Seaford, USA; Figure 1) were

implanted in the egg at one of three places (air cell, albumen or yolk) using a special needle (BMDS, Seaford, USA) after drilling a hole of 2.5 mm in the eggshell at the specific place. Before implantation the transponder, needle, drill and eggshell were decontaminated with 70% alcohol. Implantation was done at day 1 or 7 of incubation. After implanting the transponder, the hole in the eggshell was covered by tape. The control eggs were not treated at all. Eggs were opened at day 10 of incubation to determine embryonic weight and mortality. Embryo mortality was analysed using the Fisher exact test (SAS, 2002), whereas embryo weight was analysed with the GLM procedure, using day and place of implantation as main effects.

In a second experiment, the moment of implantation in the air cell was investigated more into detail. The temperature transponders were implanted in the air cell at day 1, 3, 5 or 7 and eggs were opened at day 17 of incubation to determine embryonic weight and mortality. Embryo mortality was analysed using the Fisher exact test (SAS, 2002), whereas embryo weight was analysed with the GLM procedure, using day of implantation as main effect.

Figure 1 Temperature transponder in the air cell of an egg (left) and temperature transponder on a firm and smelly yolk (right)

Results and discussion

Results of experiment 1 are summarized in the Table 1. Embryo mortality was significantly ($P<0.001$) higher in eggs in which the temperature transponder was implanted in the yolk, compared to all other places. Transponders implanted in the yolk, resulted in a firm and smelly yolk in almost all eggs (Figure 1).

Probably due to the low number of egg used, no overall significant effect of day of implantation was found. However, implantation on day 1 in the air cell resulted in a dramatically low survival rate (22%). Thus, it seems that disruption of the air cell in early incubation negatively affects the development of the embryo, although the egg membrane was not affected. What the reason is, that disturbing the air cell in early incubation leads to embryo mortality is unclear. Embryo weight was hardly affected by implantation site or day and no significant differences could be observed.

The results of the second experiment are summarized in Table 2. Again implantation of the temperature transponder at day 1 in the air cell resulted in high embryo mortality (100%). Implantation at day 3 or later resulted in survival of 50% or more, but embryo weight tended to be lower in egg implanted with a temperature transponder at day 3 or 5 compared to day 7.

In both experiments, temperature could be measured outside the egg at a distance of about 5 cm of the transponder. In current experiments no attention was given to the accuracy of the transponders. According to the manufacturer the accuracy was approximately $0.5^{o}C$. Because it is shown that small differences in incubation temperature can affect heat production (Janke et al., 2002; Lourens et al., 2006b) and consequently embryo development, an accuracy of only $0.5^{o}C$ is not acceptable. To be useful, this accuracy needs improvement.

Table 1 Effect of implantation a temperature transponder at several sites and days in the egg on embryo survival and embryo weight at day 10 of incubation.

Site and day	Number of eggs	Survival, %	Embryo weight, d 10, g (SD)
Control	24	95.8	2.61 (0.23)
Air cell	31	51.6	2.53 (0.19)
day 1	18	22.2	2.56 (0.09)
day 7	13	92.3	2.52 (0.22)
Albumen	8	75.0	2.59 (0.28)
day 1	5	80.0	2.43 (0.15)
day 7	3	66.7	2.93 (0.10)
Yolk	18	11.1	2.66 (0.04)
day 1	8	0.0	-
day 7	10	20.0	2.66 (0.04)

Table 2 Effect of implantation a temperature transponder at different days in the egg on embryo survival and embryo weight at day 17 of incubation

	Control	Air cell				SEM*	P-value*
		Day 1	Day 3	Day 5	Day 7		Day
Number of eggs	9	6	8	8	8		
Survival, %	88.9	0.0	50.0	50.0	75.0	-	<0.001
Embry weight day 17, g	17.3	-	16.0	16.5	19.3	1.1	0.08

* = only for measurements in the air cell

We conclude that implantation of temperature transponders in eggs is possible, as already demonstrated with thermistors or thermocouples connected to data loggers (e.g. Holland et al., 1998; Janke et al., 2004), but not at all sites and all days of incubation. Whether with this method embryo temperature under natural brooding conditions can be determined, needs to be investigated further and additionally attention should be given to the accuracy of the transponders.

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