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TECHNIQUE FOR IMPLANTING RADIO TRANSMITTERS SUBCUTANEOUSLY IN DAY-OLD DUCKLINGS

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Abstract.—We developed and evaluated a surgical procedure for implanting radio transmitters in 1-d-old Canvasback (*Aythya valisineria*) ducklings. Transmitters (1.5 g) were implanted subcutaneously on the back of ducklings while under a general anesthetic, isoflurane, within a few hours of hatching. Evaluations indicate that the procedure is a reliable method for radio-marking ducklings.

TÉCNICA PARA IMPLANTAR RADIOTRANSMISORES SUBCUTÁNEAMENTE A PATITOS DE UN DÍA DE EDAD

Sinopsis.—Desarrollamos y evaluamos un procedimiento quirúrgico para implantar radiotransmisores subcutáneamente a patitos (*Aythya valisineria*) de un día de edad. Los transmisores (de 1.5 g) fueron implantados en la parte dorsal pocas horas después del eclosionamiento. Se utilizó isofluorano como anestésico general. La evaluación de la técnica indica que ésta es confiable.

Determination of the timing and causes of mortality in ducklings is the focus of research for many important waterfowl species. Methods to conduct such studies on ducklings using radio telemetry have been limited previously because appropriate transmitter design and attachment techniques were unavailable. External attachment of miniature transmitters by means of harness, collar, tail-mount, suture, adhesives, and/or subcutaneous anchor have been used on a variety of waterfowl species (Dwyer 1972, Gilmer et al. 1974, Giroux et al. 1990, Greenwood and Sargeant 1973, Mauser and Jarvis 1991, Montgomery 1985, Pietz et al. 1995, Ward and Flint 1995, Wheeler 1991). We were concerned about the applicability of external attachment techniques to diving duck (*Aythya* spp.) ducklings as the transmitter may become entangled in submersed vegetation when diving (K. P. Kenow, National Biological Service, unpubl. data), affect behavior and growth, and may act as a heat sink and become an additional metabolic cost. A technique had been developed for implanting transmitters in the abdominal cavity of adult-sized ducks (Korschgen et al. 1984, Olsen 1992) but, because of the invasive nature of the procedure, we considered it unsuitable for 1-d-old ducklings.

We developed a technique to implant a transmitter subcutaneously into a duckling within a few hours of hatch that potentially would not interfere with growth or behavior of the duckling. Our objective was to develop and use surgical procedures to implant a transmitter that comply with the Animal Welfare Act (Public Law 99-198 and 9 CFR Parts 1, 2, and 3). Transmitter implant sites in wild Canvasback ducklings were evaluated during necropsies conducted by personnel with the National Wildlife Health Center, Madison, WI. Based on preliminary results, the technique was made available to other researchers and subsequently it has been used in several studies (Bakken et al. 1996, Krementz and Pendleton 1991, Zenitsky 1993). In this paper we describe the technique and provide evidence supporting its use.

METHODS

We developed the implant technique using game-farm Mallard ducklings (*Anas platyrhynchos*) for use on wild Canvasback ducklings hatched in incubators from eggs collected from nests (Korschgen et al. 1996) at the Agassiz National Wildlife Refuge, Minnesota (48°18′N, 95°59′W). Surgery was performed on ducklings after the down was dry (about 2–4 h following hatch). Radio-marked ducklings were released as broods in nests within 12 hours of hatch to ensure effective imprinting between the ducklings and nesting female (see Hess 1959). The procedures we followed to collect eggs and release ducklings are detailed in Korschgen et al. (1996).

We used crystal-controlled, 2-stage pulse internally implantable transmitters (model BD-2TI, Holohil Systems, Ltd., Woodlawn, Ontario, Canada K0A3M0; use of manufacturer's name does not imply government endorsement). The transmitter dimensions (including battery) were approximately 18 mm × 9 mm × 5 mm, mass was about 1.5 g, and transmitters had a life expectancy of 45 d. The antenna consisted of a 17-cm multi-strand twisted stainless steel wire with black nylon coating extending from the posterior end of the transmitter. Pulse rate of the transmitter was regulated by a thermistor to allow remote determination of transmitter temperature, used in this study as a cue to duckling mortality when the transmitter temperature fell below normal duckling body temperature (40 C). Transmitter components were encapsulated with physiologically inert material (Scotchcast® Electrical Resin 215, 3M, St. Paul, MN 55144).

Transmitters were activated by a magnetic reed switch before they were implanted.

Surgical procedure.—The technique required one individual trained to conduct the surgical procedure and one assistant to administer anesthetic and aid with positioning of the duckling during surgery. The surgical procedure was conducted in a portable laboratory and could be completed in 3–4 min. We initially used benzalkonium chloride aqueous solution (0.13%) (Zephiran Chloride®, Winthrop-Brean Laboratories, New York, NY 10016) to cold sterilize all surgical equipment and the transmitter, but now use chlorohexidine diacetate solution (Nolvasan® Solution, Aveco Co., Fort Dodge, IA 50501) (after Olsen et al. 1992). The duckling was positioned on a hot water bottle (40 C) in ventral recumbency with the legs extended behind the bird. The hot water bottle helped the duckling maintain body temperature, and aided with positioning the duckling during surgery and administration of anesthesia.

To anesthetize the duckling, we administered a concentration of 3.0% isoflurane (Aerrane®, Anaquest, Madison, WI 53713) with oxygen at a flow rate of 1.25 l/min by means of a 5-cc syringe case modified to serve as a mask (after Olsen et al. 1992). A surgical level of anesthesia was maintained with a 1.0–2.0% concentration of isoflurane in oxygen. Once the duckling lacked eye or toe-pinch reflex, the feathers and skin of the surgical site at the base of the neck and upper-back were soaked with benzalkonium chloride aqueous solution. The benzalkonium chloride solution was favored over surgical scrubs because it did not remove oil from the plumage. No down was removed from the surgical site. A fenestrated surgical drape was employed to reduce contamination of the surgical field and equipment. Surgical gloves were used throughout all phases of the procedure.

An 8–10-mm incision was made immediately posterior to the nape along the dorsal midline of the interscapular region using a No. 11 surgical blade in a No. 3 scalpel handle and tissue forceps. A cannula (2.80-mm OD, 2.00-mm ID, 89-mm length; distal end open with smooth edges, modified by grinding) was inserted into the incision and used to separate skin from underlying muscle posteriorly from the incision, forming a pocket between the skin and muscle for placement of the transmitter. The pocket was extended posteriorly to the synsacrum.

Next, the distal end of the cannula was placed in position at the point where the antenna was to exit and a stainless steel tube with sharpened end (1.44-mm OD, 0.90-mm ID, 100-mm length) was fed posteriorly through the proximal end of the cannula until it punctured the skin. The cannula was removed by backing it out over the stainless steel tube.

The transmitter was then removed from cold sterilization, rinsed with sterile saline solution, and the antenna threaded through the anterior end of the stainless steel tube. The stainless steel tube was removed by passing it posteriorly through the antenna exit site. The transmitter was pushed through the incision into the pocket and placed completely posterior to the incision (>4 mm) so as not to place pressure on the incision once it was closed.

We inspected the incision and removed, with fine-tip forceps, all feathers which entered the incision when the transmitter was inserted. The incision was closed using a tissue forceps, needle holder, and 4-0 polyglycolic acid suture (Dexon® "S," Davis and Beck Inc., Manati, P.R. 00701) with a mattress stitch; the needle was passed through the skin approximately 2 mm from the edge of the incision, on each side of the incision, and then brought back in the opposite direction approximately 2 mm from the edge of the incision. This closure technique positioned the edges of the incision against one another and increased the surface area of skin in contact for healing.

After surgery, pure oxygen was administered until the duckling's respiratory rate returned to normal. The duckling was held by an assistant to ensure it was warm and immobile until it regained consciousness (usually within 5 min). It was then immediately placed in a brooder maintained at 35 C. Ducklings were held until the surgical site was completely dry and down was preened (normally a minimum of 1 h) before placement in the nest bowl.

Evaluation.—After release to the wild, we attempted to locate all radiomarked ducklings and determine transmitter temperature several times daily. Dead birds were recovered as quickly as possible and cause of death was determined. Necropsies were conducted at the National Wildlife Health Center. Surgical sites were evaluated for tissue reaction to the procedure and the implanted transmitters.

RESULTS AND DISCUSSION

During 1987–1990, 226 1-d-old canvasback ducklings underwent transmitter implant surgery and were introduced into the nests of 52 canvasback females (Korschgen et al. 1996). No ducklings died during surgery and no obvious effects of surgery were noted prior to duckling release. We recovered portions of 135 duckling carcasses during the 4 years. A complete pathological evaluation was conducted on 68 (50%) of the recovered ducklings. From this sample we identified two (3%) ducklings with sufficient pathological findings associated with the transmitter implant or surgical procedure to influence the bird's survival; the transmitter implant may have been a contributing cause of death along with other factors such as weather, predation, and disease (Korschgen et al. 1996). Pathological examinations also revealed minor necrosis or inflammation at the transmitter implant site of seven (10%) ducklings, but these effects were not considered to directly contribute to the bird's mortality.

Zenitsky (1993) evaluated the effect of our subcutaneous transmitter implant procedure on the growth and behavior of 1-d-old Redhead (*Aythya americana*) ducklings by comparing control and transmitter-implanted ducklings. Surgery and implantation of transmitters had short-term effects on growth, most obvious immediately following surgery, but treatment effects were not always statistically significant. The effect of an apparent initial delay in growth of implanted ducklings on survival is unknown, given that ducklings compensated with increased growth rate shortly thereafter. Activities of control ducklings did not differ from those of transmitter-implanted ducklings.

An assessment of the potential thermoregulatory energetic costs of our subcutaneous radio implants to ducklings, under various degrees of thermal stress (combinations of temperature and wind speed), indicated the presence of a transmitter had no significant effect on net heat production (Bakken et al. 1996). The results suggested that ducklings radio-marked with subcutaneous implants were no more vulnerable to exposure than were control birds.

Krementz and Pendleton (1991) used our procedure to radio-mark Mallard and American Black Duck (*Anas rubripes*) ducklings on the Chesapeake Bay and were able to determine more accurately the causes of mortality in ducklings with radio implants than for ducklings marked with external transmitters as implanted transmitters often were consumed with the duckling and continued to transmit from the predator or were located in scat from the predator. Reobservation rates of radio-marked ducklings suggested similar survival to controls.

We suspect that most methods of marking waterfowl with radio transmitters influence survival rates to some degree (Ward and Flint 1995, Wheeler 1991). Assuming that we conducted pathological examinations on a representative sample of ducklings that died, we believe that the radio implant technique likely contributed to approximately 3% (95% CI = 0.4%–10%) of the estimated mortality in our study of Canvasback ducklings (Korschgen et al. 1996). However, radio telemetry is the only reliable method available that provides information to determine accurately the timing of death, location of carcasses, causes of mortality, detailed field evidence of habitat used, and detailed movements of individuals relative to one another (e.g., brood behavior) of highly secretive and cryptic animals such as ducklings.

We believe this subcutaneous radio implant technique is a desirable method for obtaining data on movements, daily survival rates, and cause-specific mortality of ducklings. However, the technique should only be used by experienced persons who have all of the necessary equipment and supplies. Training should be provided by a consulting veterinarian familiar with the principles of surgery. The veterinarian should verify that the trainee is competent in administration of anesthesia and the surgical procedure.

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LITERATURE CITED

Bakken, G. S., P. S. Reynolds, K. P. Kenow, C. E. Korschgen, and A. F. Boysen. 1996. Thermoregulatory effects of radiotelemetry transmitters on mallard ducklings. J. Wildl. Manage. 60:669–678.

DWYER, T. J. 1972. An adjustable radio-package for ducks. Bird-Banding 43:282–284.

GILMER, D. S., I. J. BALL, L. M. COWARDIN, AND J. H. RIECHMANN. 1974. Effects of radio packages on wild ducks. J. Wildl. Manage. 38:243–252.

GIROUX, J. F., D. V. BELL, S. PERCIVAL, AND R. W. SUMMERS. 1990. Tail-mounted radio transmitters for waterfowl. J. Field Ornithol. 61:303–309.

GREENWOOD, R. J., AND A. B. SARGEANT. 1973. Influence of radio packs on captive mallards and blue-winged teal. J. Wildl. Manage. 37:3–9.

HESS, E. H. 1959. Imprinting. Science 130:133–141.

KORSCHGEN, C. E., S. J. MAXSON, AND V. B. KUECHLE. 1984. Evaluation of implanted radio transmitters in ducks. J. Wildl. Manage. 48:982–987.

———, K. P. KENOW, W. L. GREEN, D. H. JOHNSON, M. D. SAMUEL, AND L. SILEO. 1996. Survival of radiomarked canvasback ducklings in northwestern Minnesota. J. Wildl. Manage. 60:120–132.

KREMENTZ, D. G., AND G. W. PENDLETON. 1991. Movements and survival of American black duck and mallard broods on Chesapeake Bay. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 45:156–166.

MAUSER, D. M., AND R. L. JARVIS. 1991. Attaching radio transmitters to 1-day-old mallard ducklings. J. Wildl. Manage. 55:488–491.

MONTGOMERY, J. 1985. A collar radio-transmitter attachment for wood ducks and other avian species. Proc. Int. Conf. Wildl. Biotelemetry 5:19–27.

OLSEN, G. H., F. J. DEIN, G. M. HARAMIS, AND D. G. JORDE. 1992. Implanting radio transmitters in wintering canvasbacks. J. Wildl. Manage. 56:325–328.

PIETZ, P. J., D. A. BRANDT, G. L. KRAPU, AND D. A. BUHL. 1995. Modified transmitter attachment method for adult ducks. J. Field Ornithol. 66:408–417.

WARD, D. H., AND P. L. FLINT. 1995. Effects of harness-attached transmitters on premigration and reproduction of brant. J. Wildl. Manage. 59:39–46.

WHEELER, W. E. 1991. Suture and glue attachment of radio transmitters on ducks. J. Field Ornithol. 62:271–278.

ZENITSKY, G. D. 1993. Growth and behavior of redhead ducklings implanted with dummy radio transmitters. M.S. thesis, Iowa State Univ., Ames. 156 pp.

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