A Modified Procedure for Esophageal Fistulation of Sheep

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Abstract

Esophageal fistulation provides a well-documented standard for herbivore dietary composition studies against which other methods may be calibrated. Modified surgical procedures and animal husbandry practices are described which enabled esophageal fistulas to be fitted and maintained in free ranging sheep grazing improved mountain land pastures in New Zealand.

Surgical techniques for esophageal fistulation in sheep were first described by Torell (1954) and Cook et al. (1958) then subsequently improved by Hamilton et al. (1960), McManus et al. (1962), and Bishop and Froset (1970). Esophageal fistulation has subsequently become widely accepted in herbivore diet composition studies as a standard against which alternative analytical methods should be compared (Holechek et al. 1982a, McInnis et al. 1983). Reviews on the development and use of esophageal fistulas include those of Van Dyne and Torell (1964), Theurer (1970), Rice (1970), and Holechek et al. (1982b). The success rate of early techniques was low, with numerous reports of post-operative infection and ill thrift among research animals. Refinements in surgical procedures, pre and post-operative care, and cannula types have been reflected in improved animal health and life expectancy.

The anatomy of the esophagus and surrounding structures is such that surgery will always be demanding and the possibility of post-operative infection and the formation of scar tissue high. Contamination of the operation site during surgery by rumen reflux and saliva potentially increases the risk of post-operative infection. Improved surgical procedures for establishing esophageal fistulas in sheep have generally relied upon the introduction of instruments down the esophagus to assist with its location superficially. This has precluded the use of closed circuit anesthesia machines which can provide excellent control over general anesthesis, thereby reducing the probability of rumen reflux and the possibility of subsequent infection.

This article describes a modified procedure utilizing a closed circuit anesthesis machine to maintain anesthesia while fitting esophageal fistulas in sheep. Advantages over published procedures included: (1) excellent control of rumen reflux and saliva contamination during surgery, (2) minimal tissue devitalization and post-operative swelling, (3) ease of locating and suturing the esophageal mucosa, and (4) rapid recovery of animals facilitating diet collection during the fifth post-operative week. Excellent animal health was maintained throughout an intensive 4-month collection schedule and the following 2 years during which animals were utilized periodically in diet studies. Corrective surgery was employed where necessary to maintain an optimal fistula length with respect to leakage and the recovery of extrusa. Subsequent to their development, procedures described in this article have been used repeatedly with sheep at Lincoln College during the past 10 years.

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Materials and Methods

Pre-operative Management

Six experimental animals were selected at random from a flock of 400 two and three-year old free ranging (Halfbred) nonlactating ewes grazing an 80-ha mountain land pasture near Springfield, New Zealand. Previous management of this flock involved human contact 3 or 4 times each year.

Immediately after selection sheep were subjected to 15 hr of pre-operative training for a 7-day period during which they were penned daily with the aid of a trained sheep dog. A conscious effort was made to maintain animals in an extensive management mode of behaviour throughout the 4-month trial period. Prior to surgery wool was removed from the neck and brisket using a shearing machine and then animals were fasted with water available for 24 hr.

Surgical Technique

Surgical procedures after Bishop and Froset (1970) were evaluated on the first experimental animal during which the following modified procedures were developed. The recovery and performance of this animal subsequently provided a standard for modified procedures.

Surgical anesthesia was induced with pentobarbital sodium administered intravenously. Appropriate doses for induction varied from animal to animal, but in general a dose from 15 to 25 mg/kg given slowly proved adequate. Barbiturate anesthetics are short lived in ruminants and often supplemental doses of 5 to 15 mg/kg were needed. Surgical anesthesia was maintained with an oxygen halothane mixture delivered through a close fitting mask using a closed circuit anesthetic machine with halothane vaporized at a concentration not ordinarily exceeding 2 %. The level of anesthesia was monitored clinically as acceptable when palpebral reflex was minimal and corneal reflex was strong.

The left side and midline region of the neck was clipped and prepared for surgery by multiple scrubs with a tamed iodine disinfectant. The sheep was then placed in right lateral recumbency and positioned on an inclined operating table so that the operating area in the middle third of the neck was in the highest position. The head hung over the edge of the table while the rest of the body was supported on the table, being inclined toward the anterior at approximately 30° from horizontal. This position ensured that no saliva or rumen contents flowed toward the operation site, which remained dry throughout the operation.

In the middle third of the neck a longitudinal incision of about 7.5 cm was made through the skin and subcutaneous fat about 2.5 cm below the jugular groove. Bleeding was controlled by electrocautery. The underlying muscles, the sternothyoideus and the omohyoideus, were separated by blunt dissection to expose the esophagus. In later practice insertion of an ebony rod through the esophagus facilitated its precise identification and did not preclude the use of a closed circuit anaesthetic machine.

A 2-cm long longitudinal incision was made through the wall of the esophagus, sufficient to allow the insertion of the two halves of the split-rubber-T esophageal plug diagrammed in Figure 1. Plugs were previously sterilized by prolonged soaking in tamed iodine disinfectant solution. After both halves of the esophageal plug had

been inserted and held together by a rubber ring, a purse string suture of number two catgut was applied to the skin for support 1 cm distant from the edges of the incision. The incision was then closed using an uninterrupted suture of number three catgut. Care was taken to retain the mucosa membrane of the esophagus and close it completely with the muscular layer of the esophagus and skin for complete healing. An atraumatic needle was used to prevent cutting and tearing the mucosa membrane.

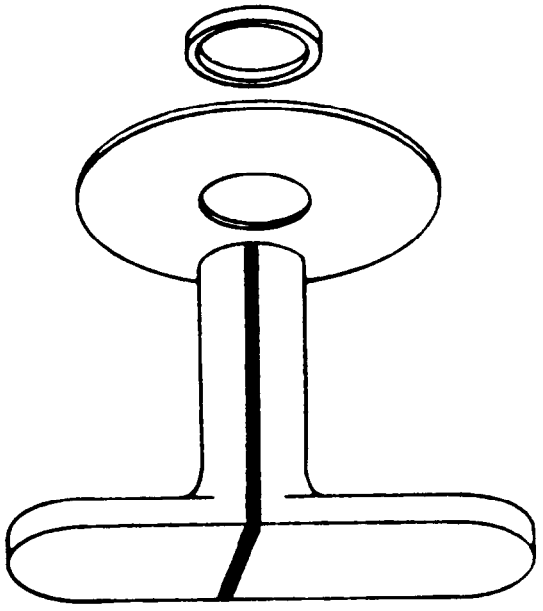

Fig. 1. *Schematic illustration of esophageal plug assembly including perspex plate and "elastrator ring".*

The surface area of the wound was then treated with topical antibiotic powder and the perspex plate shown in Figure 1 placed over the stem of the esophageal plug and retained in place with a rubber 'elastrator' ring. Anesthesia was stopped just prior to the completion of suturing. The animal recovered within 30 minutes, was able to swallow normally, and resumed feeding within 30 minutes after recovery.

Post-operative Care

Intramuscular penicillin and streptomycin were given at a dose rate of 1cc/kg liveweight for 3 days while animals were confined in separate stalls and hand fed alfalfa meal. Sheep were then returned to a mountain land grazing environment where completely healed esophageal fistulas were established in all 6 experimental animals by the fourth postoperative week.

For 3 weeks after surgery, fistulas were examined every second day and the wound treated with topical antibiotic powder. During this period only the rubber ring and perspex plate were removed and cleaned while the esophageal plug remained in position. Thereafter plugs and accessories were rotated on a weekly basis and the surgical area cleaned using running water and a soft brush, then swabbed with tamed iodine solution. Finally, after the plug assembly had been replaced, the surrounding area was treated with a regular household pyrethrin base insect spray. Plugs, rings and plates not in use were scrubbed free of esophageal deposits using a harsh nail brush and hot water containing dishwashing detergent, then air dried and stored in tamed iodine solution. Two spare plug assemblies were maintained per fistulated animal together with a range of perspex plates, each having a different outside diameter. Formation of scar tissue on the skin surrounding fistulas was prevented by weekly rotation of the outer diameter of perspex plates fitted to the esophageal plug.

Technique Evaluation

A fistula length of 50 to 60 mm (measured with the plug removed and the fistula closed) provided a functional compromise between conflicting objectives of recovering extrusa and controlling leakage. Surgery as described by Bishop and Froset (1970) proved unnecessarily complicated by rumen reflex and generated a fistula of less than 50 mm which shrank considerably during a 20-minute collection period. Persuasion needed to replace the esophageal plug after collection created additional stress to this animal and a reluctance to comply with sampling routines developed. The control of leakage was, however, excellent, as was animal health. The dimensions of fistulas established using modified procedures remained constant throughout the half-hour collection periods, and esophageal plugs were easily removed prior to and replaced after collection without stressing animals. A sampling routine was more easily established and maintained within these animals in the absence of stress associated with handling the esophageal plug. Behavioural differences between animals after the initial 7 days of collection were so marked that collections were thereafter restricted to those animals supporting fistulas established using the modified procedure.

Corrective Surgery

Esophageal fistulas established using modified procedures occasionally became enlarged after several months of regular use, necessitating corrective surgery to reduce fistula dimensions to within recommended size specifications. This was achieved by preparing animals for surgery as described previously. The perspex plate was removed and the rubber ring replaced to retain the plug in position. Depending on the degree of enlargement, toward the animal's head a fresh 1-cm longitudinal incision was made in the skin originating at the fistula. Skin was then removed from adjacent margins of the fistula back to the region in contact with the esophageal plug. A purse string suture of number two catgut was applied to the skin for support 1 cm distant from the edges of the fistula before closing the wound with an uninterrupted suture of number three catgut. The operation was completed and postoperative care administered as described previously.

Discussion and Conclusions

Properly healed esophageal fistulas, functional by the fourth postoperative week, were established using modified procedures and, with the aid of corrective surgery, remained functional for 2 years following surgery. Excellent animal health was attributed to: (1) the lack of infection and/or failure of the fistula, and (2) sound practices of hygiene and husbandry generally reflected in procedures orientated toward minimizing animal stress.

Literature Cited

Bishop, J.P., and J.A. Froset. 1970. Improved techniques in esophageal fistulation of sheep. Amer. J. Vet. Res. 31:1505-1507.

Cook, C.W., J.L. Thorne, J.T. Blake, and J. Edlefsen. 1958. Use of an esophageal fistula-cannula for collecting forage samples by grazing sheep. J. Anim. Sci. 17:189-193.

Hamilton, F.S., W.R. McManus, and L.H. Larson. 1960. An improved method of esophageal fistulation for food intake studies in sheep. Aust. Vet. J. 36:111-112.

Holechek, J.L., M. Vavra, and R.D. Pieper. 1982a. Botanical composition determination of range herbivore diets: a review. J. Range Manage. 35:309-315.

Holechek, J.L., M. Vavra, and R.D. Pieper. 1982b. Methods for determining the nutritive quality of range ruminant diets: a review. J. Anim. Sci. 54:363-376.

McInnis, M.L., M. Vavra, and W.C. Krueger. 1983. A comparison of four methods used to determine the diets of large herbivore. J. Range Manage. 36:302-306.

McManus, W.R., G.W. Arnold, and F.J. Hamilton. 1962. Improved techniques in esophageal fistulation of sheep. Aust. Vet. J. 38:275-281.

Rice, R.W. 1970. Stomach contents analysis: a comparison of the rumen vs esophageal techniques. *In:* Range and Wildlife Habitat Evaluation. A Res. Symp., USDA, For. Serv. Misc. Pub. 1147.

Theurer, C.B. 1970. Determination of botanical and chemical composition of the grazing animals diet. p. J1-J17. *In:* Proc. Natl. Conf. Forage Quality Evaluation and Utilization. Nebraska Center for Continuing Education, Lincoln.

Torell, D.T. 1954. An esophageal fistula for animal nutrition studies. J. Anim. Sci. 13:878-884.

Van Dyne, G.M., and D.T. Torell. 1964. Development and use of the esophageal fistula: A review. J. Range Manage. 17:7-19.