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Enteral Feeding of 3 Mature Cows by Rumenostomy

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Rumenostomy is the creation of a permanent or semi-permanent rumen fistula. Permanent rumen fistulation is performed to facilitate nutritional research or provide rumen fluid donors.[1,2] Transfaunation is an effective adjunctive therapy in cattle recovering from surgery.[2] Texts have recommended the use of rumenostomy to provide symptomatic relief in cattle with recurrent bloat.[1] This report describes the use of rumenostomy and enteral feeding as adjunctive therapy in cows unable to eat or drink. Repeated oroesophageal intubation may not be tolerated by many cattle and the diameter of stomach tubes typically precludes provision of large volumes of feedstuffs.

A 4-year-old, 510 kg, female Holstein dairy cow was examined because of profuse drooling of 2 days' duration. The cow's milk production was greatly decreased. The owner reported that the cow made frequent unsuccessful attempts to eat and drink. The cow calved 1 week before presentation. The cow's diet consisted of undetermined amounts of corn silage, grass hay, and ground feed. The owner treated the cow with procaine penicillin G[a] (20,000 IU/kg SQ q24h) the day before presentation.

The cow was depressed. Rectal temperature was 37.4°C, heart rate was 80 beats/min, and respiratory rate was 52 breaths/min. The cow was estimated to be 8% dehydrated as assessed by skin turgor. A right head tilt was noted. Marked drooling was noted and the cow's tongue was deviated to the left side of the oral cavity. The cow had facial analgesia of the right side and was nonresponsive to tactile stimuli of the right ear. Palpebral, corneal, and menace responses were absent in the right eye. A corneal ulcer was noted on the right eye. The cow had proprioceptive deficits in both hindlimbs. Rumen contents were firm on rectal palpation, but rumen contractions were normal (2 contractions/min).

On urinalysis, acidiuria (pH, 6.5; normal, 7–9) and proteinuria (300 mg/dL; normal, <30 mg/dL) were present. Leukocytosis (14,700 cells/μL; normal, 4,000–12,000 cells/μL) characterized by a neutrophilia (10,440 segmented cells/μL; normal, 600–4,000 cells/μL) was identified on CBC. Venous blood gas analysis indicated a metabolic acidosis (pH, 7.19; normal, 7.35–7.5), bicarbonate concentration (9.7 mmol/L; normal, 17–29 mmol/L), TCO_2 (10.5 mmol/L; normal, 19–29 mmol/L), and a base deficit of 18.7 mmol/L. Results of serum biochemical evaluation included increased concentrations of urea nitrogen (44 mg/dL; normal, 6–22 mg/dL), creatinine (1.4 mg/dL; normal, 0.5–1.1 mg/dL), glucose (218 mg/L; normal, 44–78 mg/dL), protein (9.2 g/dL; normal, 5.8–7.5 g/gL), albumin (3.8 g/dL; normal, 2.4–3.5 g/dL), and globulins (5.4 g/dL; normal, 2.3–3.9 g/L). Serum activity of AST (202 U/L; normal, 58–100 U/L), GGT (75 U/L; normal, 22–64 U/L), and creatine kinase were increased (1,365 U/L; normal, 56–1,236 U/L). Cerebrospinal fluid (CSF) analysis identified increased total protein concentration (113 mg/dL; normal, 20–40 mg/dL); increased lymphocytes, monocytoid cells, and activated macrophages (83 cells/μL; normal, <6 cells/μL). A quantitative differential cell count was not provided. Based on the clinical signs and CSF analysis results, a presumptive diagnosis of listeriosis was made. *Listeria monocytogenes* was not recovered from CSF culture, but negative microbiologic cultures are common in cattle with listeriosis.[3–5]

A rumenostomy was performed. Base deficit for the cow was calculated as follows: base deficit (mmol/L) = 0.5 × 510 kg × 18.7 mmol/L = 4769 mmol.[6] The fluid deficit was calculated as 510 kg × 0.08 = 40.8 L. The maintenance fluid requirement was estimated as an additional 40.8 L/d (80 ml/kg/d).[7] Given that 1 g $NaHCO_3$ provides approximately 12 mmol of bicarbonate, the cow required approximately 400 g of sodium bicarbonate to replace the base deficit. Initially, 30 L of water, 3 times per day, was administered via rumenostomy. At each administration of water, 50 g of potassium chloride, 40 g of calcium chloride, and 130 g of sodium bicarbonate were dissolved in the water. The cow was fed 1.5 kg of a balanced commercial dairy cow grain mix[b] and 2.5 kg of pelleted alfalfa[c] 3 times per day through the rumenostomy, providing approximately 17.5 Mcal net energy (NE)/day.[8] Grain and pelleted alfalfa were added dry through a funnel and electrolyte solutions were administered through the rumenostomy using a large-bore stomach tube at each feeding. Oxytetracycline[d] at 10 mg/kg was administered IV once daily. A topical ophthalmic antibiotic ointment[e] was administered OD, q12h.

Serum chemistry determinations repeated 24 hours after admission demonstrated that the cow had mild metabolic acidosis (pH, 7.31; base deficit, 4.6 mmol/L; bicarbonate concentration, 21.8 mmol/L; TCO_2, 23.2 mmol/L). Intraruminal fluid and electrolyte administration was continued. Based on the measured deficit, the amount of sodium bicarbonate administered through the rumenostomy was adjusted to 30 g q8h. Intraruminal calcium chloride and potassium chloride were continued. Three days after presentation, the cow was able to eat and drink slowly, but with great difficulty. Serum chemistry determinations on day 3 after presentation were consistent with a normal acid–base

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status (pH, 7.43; bicarbonate concentration, 26.3 mmol/L), and enteral sodium bicarbonate, calcium chloride, and potassium chloride administration were discontinued. Daily voluntary water intake by the cow was measured and calculated deficiencies based on maintenance fluid intake requirements were administered via the rumenostomy. Enteral feeding of grain and pelleted alfalfa through the rumenostomy was continued. The cow's milk production had increased from 8 kg to 23 kg a day. Facial sensation on the right side was improved and drooling was absent 6 days after presentation. Seven days after presentation, feed and water administration through the rumenostomy was discontinued. The cow was discharged 9 days after presentation. A commercial rumen cannula[f] was placed in the rumenostomy site. Antibiotic therapy was discontinued on the day of discharge. The client reported that the cow was asymptomatic 14 days after discharge.

A 7-year-old, 600 kg, Holstein cow was referred for evaluation of mandibular fractures. The cow's head was accidentally crushed between a skid loader bucket and a steel beam 3 days before referral to our clinic. The cow was 6 months pregnant and producing 25 kg of milk per day before the injury. The cow was dried off after the injury to facilitate treatment and decrease the cow's nutritional requirements.

The cow was alert, rectal temperature was 39.0°C, pulse was 66 beats/min, and respiratory rate was 28 breaths/min. The fractures were complete, open, and involved both rami of the mandibles. Rectal examination confirmed a fetus of 6 months' gestational age.

Radiographic evaluation of the mandible identified fractures of the right and left rostral mandible. The left mandible was fractured lateral and caudal to the fourth incisor, whereas the right mandible was fractured between the second and third incisors. The rostral fragment was displaced cranially and to the right. Widening of the radiolucent lamina dura of the 1st, 2nd, and 3rd incisors on the right and the 1st and 2nd incisors on the left was present. Mild comminution of the fracture was observed. Results of serum biochemical evaluation disclosed hyperglobulinemia (5.2 g/dL; normal, 2.6–5.1 g/dL), hypocalcemia (8.2 mg/dL; normal, 8.7–10.1 mg/dL), increased total bilirubin concentration (0.9 mg/dL; normal, 0.1–0.3 g/dL), and increased activity of creatine kinase (884 U/L; normal, 103–230 U/L).

Oxytetracycline[g] therapy administered at 20 mg/kg SC q72h was initiated before fracture reduction. The fracture was surgically repaired under sedation with butorphanol[h] (0.03 mg/kg) and xylazine[i] (0.05 mg/kg). Initially, the fracture was repaired using intramedullary pins and methyl methacrylate[j] as an external fixator.[9] The cow's mouth was taped closed with duct tape. Immediate postsurgical radiographs confirmed reduction of the fracture. A rumenostomy was performed concurrently for enteral feeding. The cow was fed 1.5 kg of grain and 2 kg of pelleted alfalfa q8h, providing approximately 15.7 Mcal NE/day.[8] Grain and pelleted alfalfa were added dry through the rumenostomy using a funnel. Twenty liters of water were administered through the rumenostomy using a large-bore stomach tube at each feeding. Enteral feeding was continued for the next 4 weeks.

Radiographic evaluation performed 2 weeks after admission indicated minimal callus formation on the fracture sites. Clinical assessment at this time was that the intramedullary pins were loose and providing minimal stabilization. Consequently, the intramedullary pins were removed and replaced with tension band wires. One wire incorporated the 4 right incisors and the 1st left incisor, bridging the fracture site. A 2nd wire incorporated the 4 left incisors and the 1st right incisor, providing support for the 1st and 2nd right incisors. A 3rd wire incorporated the 2nd, 3rd, and 4th left incisors and was anchored in the mandible between the 1st and 2nd left premolars, providing caudal tension. Additional stabilization was provided by an external splint device consisting of flat, wooden splints placed on the ventrolateral aspect of each mandible. The splints were secured to the head using duct tape around the maxilla and the poll of the head. This device also held the cow's mouth closed. Four weeks after admission, the stabilization device was removed every 4 h to allow the cow to eat and drink for 10–15 minutes. Six weeks after admission, radiographic evaluation indicated good alignment of the fracture site with adequate callus formation. The stabilizing device was removed and the rumenostomy surgically closed. The cow was discharged. The tension band wires were removed 3 weeks after discharge. Follow-up communications with the client indicated that the cow calved unassisted 3 months after discharge and the fracture had healed completely.

An 8-month old, 216-kg Beef Shorthorn heifer was examined for dyspnea, bloat, and a swollen neck. The heifer had bloated the day before presentation while at a livestock exhibition. Several attempts were made to relieve the bloat by oroesophageal intubation. The morning before presentation, the bloat resolved, but the heifer became dyspneic and had a swollen neck. The swelling on the neck extended from the mandible to the thoracic inlet.

The heifer was recumbent, bloated, and breathing with an open mouth. Rectal temperature was 38.9°C, pulse was 96 beats/min, and respiratory rate was 28 breaths/min. Marked swelling extended from the submandibular region to the thoracic inlet. The trachea and jugular veins could not be palpated because of the swelling, and the heifer could not eat or drink. Leukoctyosis (19,700 cells/μL; normal, 4,000–12,000 cells/μL) and neutrophilia (14,972 cells/μL; normal, 600–4,000 cells/μL) were noted on CBC. Radiographs of the neck and thorax disclosed multiple linear areas of decreased radiographic opacity suggestive of air or gas throughout the soft tissues of the larynx and neck. In addition, both the dorsal and ventral walls of the esophagus could be visualized in the caudal dorsal thorax. Endoscopy of the pharynx, larynx, and esophagus identified swollen arytenoids and a mucosal tear dorsal to the arytenoids on the right side of the pharynx. The walls of the esophagus were intact. We hypothesized that the oroesophageal tube had exited the oral cavity through the tear, causing cellulitis of the submandibular region and the neck, preventing the heifer from eructating.

An IV catheter was placed in the ear vein and lactated Ringer's solution was administered at 50 mL/kg/d. The primary reason for the IV catheter placement was to permit administration of antibiotics and anti-inflammatory agents. Flunixin meglumine[k] (1.1 mg/kg IV q12h) and procaine penicillin G[a] (30,000 IU/kg q24h) were administered. A

rumenostomy was performed. The heifer was fed 1 kg of grain, 1.5 kg of pelleted alfalfa q8h, providing approximately 11.1 Mcal NE/day.[8] Grain and pelleted alfalfa were fed dry through the rumenostomy using a funnel. Ten liters of water also were administered through the rumenostomy q8h at each feeding using a large-bore stomach tube.

Although the heifer had access to free-choice grass hay, she could not eat until the 8th day after presentation, at which time the subcutaneous emphysema had decreased markedly. Intravenous fluids and flunixin meglumine were discontinued on day 8 after presentation. Antibiotic therapy was changed to oxytetracycline (10 mg/kg IV q24h for 6 days) and sulfadimethoxine[l] (55 mg/kg PO on the first day and 27.5 mg/kg PO q24h thereafter for 4 days). Feeding through the rumenostomy was discontinued 29 days after presentation. The rumenostomy was surgically closed and the heifer discharged.

Considerable feed and water are required for maintenance in adult cattle. Mature lactating beef cows with average milking ability (4.5 kg milk/d) with an average weight of 500 kg require approximately 11.5 Mcal NE/d for maintenance.[10] A mature lactating dairy cow (average weight of 600 kg, Holstein) requires 9.7 Mcal NE/d for maintenance.[10,11] Net energy requirements for lactation vary with the level of production.[8,10,11] Maintenance requirements are readily met by feeding via rumenostomy but it may be difficult to meet the requirements for maximal production in lactating dairy cattle. For instance, the first cow presented required 8.46 Mcal NE/d for maintenance.[10,11] At the level of production (23 kg of milk per day before discharge), the net energy for lactation required by the cow would be 22.3 Mcal NE/d.[11] Net energy provided per day by the grain and pelleted alfalfa was based on the net energy composition of these feeds and was calculated as follows: 4.5 kg grain/d $\times$ 1.91 Mcal NE/kg + 7.5 kg alfalfa/d $\times$ 1.19 Mcal NE/kg = 17.5 Mcal NE/d.[8] Enteral feeding approached, but did not meet, the net energy requirements in this cow. However, considering the milk production before presentation (40 kg), net energy requirements for the first cow would have been 36 Mcal NE/day.[11] Such energy demands would have been difficult to meet through a rumenostomy because impractically large amounts of ground feedstuff would be required. Nevertheless, the use of rumenostomy permitted us to meet calculated maintenance caloric and fluid requirements. The use of finely ground feedstuffs (concentrates or ground forages such as alfalfa pellets) reduces rumination,[10,12] which may be advantageous in cattle with dysphagia. In each cow, rumenostomy permitted adequate feed administration while the necessity for regurgitation and cud chewing was reduced. The use of ground forages as the principal feed source rather than concentrates, as described in this report, probably decreases the potential for digestive upsets and grain engorgement.

Supplementation of potassium and calcium in the first cow was deemed necessary even though serum concentrations were within reference ranges because correction of the base deficit was anticipated to move potassium intracellularly with a risk of hypokalemia.[7] In addition, cattle with metabolic acidosis may have normal serum potassium concentration in the extracellular compartment but total body potassium stores may be low.[7] Alkalinizing solutions also may reduce the proportion of ionized calcium; hence, calcium supplementation should be considered.[7] Enteral feeding of mature cattle should be considered as a means of providing adequate nutrition in adult cows with temporary dysphagia for various reasons.

Footnotes

[a] Procaine penicillin G, G.C. Hanford Mfg Co, Syracuse, NY
[b] Custom Mixes, Bourne Feed and Supply Inc, Columbia, MO
[c] Dehydrated alfalfa, Consolidated Blenders Inc, Hastings, NE
[d] Oxybiotic −100, The Butler Co, Columbus, OH
[e] Trioptic-P, Altana Inc, Melville, NY
[f] Cannula, Bar-Diamond Inc, Parma, ID
[g] Liquamycin LA 200, Pfizer Animal Health, Exton, PA
[h] Torbugesic, Fort Dodge, Madison, NJ
[i] Xyla-jet, Phoenix Pharmaceutical Inc, St Joseph, MO
[j] J-61LB Technovite liquid and powder, Jorgensen Laboratories, Loveland, CO
[k] Flu-meglumine, Phoenix Pharmaceutical Inc, St Joseph, MO
[l] Albon, Pfizer Animal Health, Exton, PA

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