Indian Journal of Animal Sciences **92** (12): 1375–1379, December 2022/Review Article
https://doi.org/10.56093/ijans.v92i12.101312

Developments in buffalo anaesthesia with special reference to diaphragmatic herniorrhaphy

R N CHAUDHARY[1]✉ and POOJA YADAV[2]

Lala Lajpat Rai University of Veterinary and Animalal Sciences, Hisar, Haryana 125 004 India

Received: 18 June 2020; Accepted: 26 October 2022

ABSTRACT

Ruminants are poor subject for general anaesthesia. Diaphragmatic hernia (DH) is a common digestive disorder in buffaloes requiring balanced general anaesthesia for surgical repair. For premedication, initially, a combination of phenothiazine/chloralhydrate was used which was later replaced by alpha2 agonist like xylazine. Anticholinergics like atropine or glycopyrrolate were included in balanced anaesthetic protocols to reduce cardiac depression by alpha2 agonists. Thiobarbiturates historically were used for induction and maintenance but late recovery and cardiorepiratory depression lead to switch over to propofol. Maintenance of anaesthesia by top-up or continuous rate infusion (CRI) of propofol was not economical. The inclusion of opioids like butorphanol improved the analgesia as well as has dose sparing effect on induction and maintenance agent. The introduction of inhalants for maintenance significantly improved outcomes with the ease of change of depth of anaesthesia. It has also been observed that adrenocortical suppression by etomidate and mechanical intermittent positive pressure ventilation (IPPV) resulted in poor outcomes whereas maintaining the homeostasis and functional adreno-cortical axis of buffaloes under anaesthesia improves the success rate of DH surgeries. The balanced anaesthetic combination of Atropine/xylazine/butorphanol/propofol/isoflurane has been found to be most satisfactory till date in buffaloes undergoing DH surgery. The studies on muscle relaxants, blood gas analysis and end tidal carbon dioxide ($EtCO_2$) in buffaloes are scarce. Moreover, many drugs have been used in combinations in clinical cases on the basis of extrapolation from other species; but in buffaloes the effect of individual drug (like dose sparing effect of analgesics, minimum alveolar concentration (MAC) of inhalants) has to be still studied.

Keywords: Anaesthesia, Buffalo, Diaphragmatic hernia, Propofol, Thiopentone

Diaphragmatic hernia (DH) has frequently been reported in buffaloes since 1960s (Iyer 1969, Naik and Mahandale 1969, Doere and Jahagirdar 1971, Dhablania *et a1.* 1971). The repair of the diaphragmatic defect needs general anaesthesia along with controlled ventilation (Singh *et al*. 2006). There is severe pain during diaphragmatic herniorrhaphy, so to achieve analgesia during anaesthesia, different analgesic drugs have been used which act on peripheral and central nervous system. General anaesthesia in bovines causes various complications like excessive salivation, regurgitation, tympany and cardiopulmonary depression. So, a multiple drug approach (balanced anaesthesia) is preferred.

Initially, for anaesthesia in buffalo calves, a combination of promazine/chloral hydrate/Nembutal was used and reported to be safe as no excitement was observed during induction and recovery, however, fasting of the animal was essential. Later, thiopentone sodium with advantages in induction and maintenance replaced Nembutal and was used extensively for induction and maintenance of general anaesthesia in buffaloes (Prasad *et al.* 1977, Singh *et al.* 1977, Krishnamurthy *et al.* 1980). To prolong the duration of anaesthesia and better muscle relaxation without increasing the dose of thiopentone, a mixture of chloral hydrate and magnesium sulphate (chlor-mag) was added in the protocol as preanaesthetic. This combination of chlor-mag /thiopentone produced surgical anaesthesia for 30-35 min in buffalo calves with a good margin of safety (Nigam *et al.* 1983) and was routinely used in water buffaloes for almost a decade.

After the introduction of xylazine in veterinary practice for sedation and chemical restraining of different animals in Europe, Peshin and Kumar (1979) tested xylazine in buffalo calves and reported a moderate amount of salivation with outstanding sedation, muscle relaxation, bradycardia and hypotension following its parenteral administration. Ramakrishna *et al.* (1981) also observed marked salivation after administration of xylazine in buffalo calves.To reduce bradycardia, hypotension and salivation, when Peshin and Kumar (1979) premedicated the buffalo calves with atropine, the xylazine caused lesser reduction in arterial blood pressure, heart rate and respiratory rate as well as reduced quantity of salivation than xylazine alone.

Present address: [1]College of Veterinary Science, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar, Haryana. ✉Corresponding author email: rncvet@luvas.edu.in

Premedication of atropine also moderated respiratory acidosis and hypoxaemia in buffalo calves sedated with xylazine (Peshin *et al*. 1986). When another anticholinergic, glycopyrrolate, alone was administered in buffalo calves, it also produced tachycardia without significant change in mean arterial pressure, and it's premedication before xylazine improved heart rate and mean arterial pressure than xylazine alone (Khan *et al.* 2007). When glycopyrrolate was used in buffalo as preanaesthetic to diazepam/thiopentone anaesthesia in buffalo calves, initially the heart rate and mean arterial pressure (MAP) increased gradually after diazepam but these decreased to normal after thiopentone administration. The diazepam/thiopentone combination had the main disadvantage of increased arterial pCO_2 considerably high and arterial hypoxaemia was observed (Bindlish *et al*. 2012). Potliya *et al*. (2015) compared atropine and glycopyrrolate in buffaloes undergoing diaphragmatic herniorrhaphy, sedated with xylazine and induced by propofol reported no significant difference reported between two combinations, but the atropine was more economical.

The small volume required, ease of administration and profound effects of xylazine as sedative, muscle relaxant and analgesic making the buffaloes amenable for induction and maintenance, made xylazine a popular preanaesthetic in veterinary anaesthesia for water buffaloes. When xylazine was administered before ketamine or combination of xylazine/ketamine, the combination produced satisfactory anaesthesia only for 30-45 min with good muscular relaxation without significant depression in cardiovascular function (Singh *et al*. 1985). Xylazine premedication in buffaloes significantly reduced the dose of thipentone for induction without blood biochemical alterations except for an increase in blood glucose (Kumar and Sharma, 1986). When Pawde *et al.* (2000) used another alpha-2 agonist detomidine instead of xylazine, in combination with diazepam-ketamine for anaesthesia in buffalo calves, this combination was also safe but suitable for only short duration (15 min) anaesthesia with excellent muscle relaxation and limited cardiorespiratory effects. So, the need for maintenance with inhalant was felt as diaphragmatic herniorrhaphy in buffalo usually requires around requires 40-60 min of general anaesthesia. When acepromazine was compared with xylazine as sedative in combinations of atropine/butorphanol/thiopentone/sevofluranein buffaloes undergoing diaphragmatic herniorrhaphy, xylazine produced rapid sedation and early recovery in buffaloes as compared to acepromazine but the acepromazine resulted in lower maintenance dose requirement of sevoflurane than with xylazine (Jamdagni *et al*. 2020). The replacement of thiopentone by propofol in this combination also produced the similar results (Kishore *et al*., 2019).

For the benefits of better analgesia and dose sparing effect, Sharma (2011) added different opioida and non-steroidal anti-inflammatory drugs (NSAID) viz. butorphanol, pentazocine and dipyrone, it was reported that both the opioids (butorphanol and pentazocine) have comparable effects and better analgesic effect than Dipyrone (NSAID) during peri- and post-operative period. Singh *et al*. (2013) also compared the opioid fentanyl and an alpha2 agonist medetomidine in buffalo calves induced with thiopentone and maintained on halothane, and reported that electrolyte balance was better preserved when premedicated with medetomidine but there was significant rise in $PaCO_2$ and HCO_3 and significant decrease in pH and PaO_2.

Ninu *et al.* (2015) compared thiopentoen and ketamine as induction agent after glycopyrrolate/acepromazine/xylazine premedication in buffaloes undergoing diaphragmatic herniorrhaphy, and reported that the combination with ketamine was more suitable for short duration surgical anaesthesia with early recovery whereas the combination with thiopentone was better for longer duration (>40 min) anaesthesia with better muscle relaxation but the recovery was delayed. Chaturvedi *et al.* (2013) also reported glycopyrrolate/acepromazine/xylazine/thiopentone combination to be safe and produced anaesthesia of surgical plane in buffalo calves with minimal side effect. When ketamine was combined with either midazolam or diazepam, it appeared to be safe for general anaesthesia in buffalo calves with minimum cardio-pulmonary and biochemical changes (Kumar *et al*. 2014a, b). When thiopentone was replaced with propofol as induction agent and maintenaned with halothane/Nitrous oxide/Oxygen, there were no significant differences in recovery times and haemato-biochemical parameters (Hall and Peshin 1996). When Propofol was used as sole anaesthetic agent in cattle calves, it did not cause any significant changes in clinical, blood gases and biochemical values but was only useful for short duration simple surgical procedures (Genccelep *et al*. 2005), however, in buffalo calves it caused significant increase in heart rate with increased mean arterial pressure (MAP) and decreased central venous pressure (CVP) (Kumar *et al.* 2011). Low doses of propofol does not cause any excitement in buffalo calves and the induction was smooth (Ratnesh *et al.* 2014). Propofol in combination with triflupromazine was also safe for short duration surgery in buffalo calves. When propofol, xylazine+ketamine and ketamine+propofol (ketofol) were tested as induction as well as maintenance agent through CRI after premedication with atropine/butorphanol/Xylazine+ketamine, the induction and maintenance with Propofol was more safe and better than xylazine+ketamine and ketofol combinations in terms of analgesia, perfusion, smooth and early recovery in buffaloes undergoing diaphragmatic herniorrhaphy (Jakhar 2012). Potliya *et al*. (2015) also reported that in buffaloes undergoing diaphragmatic herniorrhaphy, propofol was better induction agent than xylazine/ketamine combination. The buffaloes suffering with DH are usually compromised in cardiopulmonary function and etomidate is known for its least cardiopulmonary depression, so Sharma (2019) compared propofol and etomidate as induction agent in buffaloes undergoing diaphragmatic herniorrhaphy, in balanced anaesthetic combinations of glycopyrrolate/dexmedetomidine/xylazine/pentazocine followed by

either of isoflurane or sevoflurane for maintenance, and reported that though etomidate had lesser cardiopulmonary depression effects than propofol but the intra and post-operative complications including mortality were more with etomidate than with propofol. Also, the buffaloes anaesthetized with etomidate had lower cortisol level than with propofol upto 24 h of recovery due to adrenocortical suppression. So, propofol was better and as well as economical induction agent than etomidate.

The delayed recovery in buffaloes after CRI or top up maintenance doses of thiopentone resulted in frequent complications like radial paralysis whereas high cost of propofol in longer duration surgeries of buffaloes made the use of inhalant inevitable. Inhalant anesthetics also undergo least metabolism inside compromised body of buffaloes suffering with DH. It also facilitates better control over depth of anaesthesia intraoperatively as well as early recovery. These advantages prompted Gahlawat *et al.* (1986) to test halothane for maintenance of anaesthesia in buffalo calves after induction with thiopentone sodium. Besides above mentioned advantages, there were no significant changes in hemoglobin, packed cell volume, plasma glucose, creatinine, total proteins and plasma electrolytes. When thiopentone was replaced with propofol as induction agent and anaesthesia was maintained with halothane/Nitrous oxide/Oxygen, there were no significant differences in recovery times and alteration in haemato-biochemical parameters (Hall and Peshin 1996). Propofol was found to be a good induction agent for halothane anaesthesia in buffaloes undergoing DH surgery but maintenance was not smooth due to less analgesia (Potaliya 2015). With the advent of inhalants with better properties like isoflurane, when halothane was compared isoflurane for maintenance after thiopentone induction in water buffaloes, the recovery from anesthesia with isoflurane was more rapid than with halothane (Bodh *et al*. 2014). Also, isoflurane was associated with a lesser degree of cardiovascular, respiratory, and hemodynamic depression than halothane. Acid base parameters and plasma electrolytes were minimally affected during isoflurane maintenance anesthesia. Isoflurane maintenance anesthesia provided better quality of recovery and was associated with minimum side effects. Singh *et al*. (2012) also reported isoflurane to be better than halothane in respect of better preservation of cardiopulmonary functions after Fentanyl/ medetomindine premedication and thiopentone induction in buffalo calves. However, addition of dexmedetomidine instead of medetomindine improved clinical, physiological and haemodynamic stability (Singh *et al*. 2013). Potalia (2015) also supported that isoflurane was better maintenance agent than halothane in buffaloes undergoing DH surgery.

Chaudhary *et al*. (2017 and 2020) introduced sevoflurane as maintenance agent in buffalo anaesthesia and compared its effect with isoflurane in buffaloes undergoing diaphragmatic herniorrhaphy. They reported that sevoflurane was slightly better maintenance agent than isoflurane, in terms of earlier recovery and no breath holding in buffaloes undergoing diaphragmatic herniorrhaphy but the cost of anaesthesia increased to almost double. Induction with propofol resulted in earlier recovery than induction with xylazine+ketamine or thiopentone and maintained on either sevoflurane or isoflurane.

Both the isoflurane and sevoflurane are highly halogenated compound and supposed to be highly genotoxic on administration which may have further dangerous sequelae on buffalo patient as well as surgical team. So a compound being less genotoxic is more preferred for use in anaesthesia. Based on the expression analysis of buffalo *OGG1* gene (involved in repair of DNA), it was observed that the balanced anaesthetic combinations maintained with either of inhalant where the recovery was earlier (i.e. propofol/sevoflurane and propofol/isoflurane combination than thiopentone/ xylazine+ketamine/-isoflurane and thiopentone/xylazine+ketamine/ sevoflurane respectively) were less genotoxic than where recovery was delayed (Chaudhary *et al*. 2019). So on the basis of genotoxicity, there was no significant difference between isoflurane and sevoflurane.

Till date no muscle relaxant are being routinely used in balanced anaesthetic protocols for diaphragmatic herniorrhaphy in buffaloes. Inclusion of muscle relaxants is desired in anaesthetic combinations when mechanical ventilation is to be performed. Dhankar *et al*. (2016) made a preliminary study on the muscle relaxants in buffalo claves and reported that vecuronium was better muscle relaxant than pancuronium in terms of early onset of action, rapid and smooth recovery and cardiovascular stability.

It is concluded that the balanced anaesthetic combination of atropine-xylazine-butorphanol-propofol-isoflurane has been found to be most satisfactory till date for use in buffaloes undergoing anaesthesia for diaphragmatic herniorrhaphy on the basis of smooth and early induction as well as recovery, lesser cardiopulmonary depression with minimal changes in haemato-biochemical parameters and cost of anaesthesia. Most of the studies have not included blood gas analysis, $EtCO_2$ measurement during anaesthesia and haemodynamics paramaters. Inclusion of these will further validate the findings. Muscle relaxants have not been used in any protocol used for DH; however, this will hypothetically facilitate the mechanical intermittent positive pressure ventilation (IPPV). The inhalant agents are highly halogenated and reactive. So more studies should be conducted to develop a balanced anaesthetic protocol having least genotoxic effect.

REFERENCES

Bindlish S, Singh S, Kumar A, Peshin P K and Singh K. 2012. Evaluation of glycopyrrolate-diazepam-thiopentone anaesthesia in buffaloes. *Haryana Veterinarian* **51***:* 50–52.

Bodh D, Singh K, Gopinathan A, Mohindroo J and Saini N S. 2014. Comparative evaluation of halothane and isoflurane maintenance anaesthesia in water buffaloes (*Bubalus bubalis*). *Journal of Applied Animal Research* **42**(3): 269–77.

Chaturvedi S, Singh K, Kumar A, Singh J and Singh S. 2013. Evaluation of glycopyrrolate-acepromazine-xylazine-

thiopentone for general anaesthesia in buffalo calves. *Indian Journal of Veterinary Surgery* **34**(1): 23–26.

Chaudhary R N and Tayal R. 2020. Evaluation of sevoflurne and isoflurane as maintenance agent in buffaloes after glycopyrrolate–xylazine-butorphenol-propofol anaesthsia. *Indian Journal of Animal Research* **54**(2): 209–15.

Chaudhary R N, Tayal R, Behl S M, Kumar A and Sharma S. 2017. Comparative evaluation of isoflurane and sevoflurane for maintenance of anaesthesia in buffaloes undergoing diaphragmatic herniorrhaphy. *Indian Journal of Animal Sciences* **87**: 701–06.

Chaudhary R N, Tayal R, Kumar A and Batra K. 2019. Genotoxicity evaluation of isoflurane and sevoflurane in anaesthesized buffaloes. *Indian Journal of Veterinary Surgery* **40**(1): 44–47.

Dhablania D C, Tyagi R P S and Nigam J M. 1971. A study on diaphragmatic hernia in bovines. *Indian Veterinary Journal* **48**: 91.

Dhankar A. 2016. 'Studies on comparative evaluation of pancuronium and vecuronium as muscle relaxants in buffaloes.' M.V.Sc. Thesis submitted to Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar.

Doere P A and Jahagirdar S S. 197l. Incidence of diaphragmatic hernia in cattle and buffaloes: Case record of 16 cases. *Indian Veterinary Journal* **48**: 1172.

Gahlawat J S, Singh A P, Singh J and Peshin P K. 1986. Evaluation of halothane anaesthesia with intermittent positive pressure ventilation in buffalo calves (*Bubalus bubalis). Arch. Exper. Veterinarian Med. Leipzig*. **40**: 876–80.

Genccelep M, Aslan L, Sahin A and Sindak N. 2005. Effect of propofol anaesthesia in calves. *Indian Veterinary Journal* **82**: 516–18.

Hall L W and Peshin P K. 1996. Propofol-halothane-nitrous oxide/oxygen anaesthesia for megavoltage radiotherapy in dogs. *Veterinary Anaesthesia and Analgesia* **23**: 20–22.

Iyer C R. 1969. Diaphragmatic hernia in buffaloes. *Indian Veterinary Journal* **46**: 918.

Jakhar P. 2012. 'Evaluation of xylazine-ketamine-propofol anaesthesia in buffaloes subjected to diaphragmatic herniorrhaphy.' M.V.Sc. Thesis submitted to Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar.

Jamdagni M, Kumar A, Chaudhary R N, Tiwari D K, Arora N, Kumar S and Kishore V. 2020. Studies on efficacy and safety of atropine-acepromazine-butorphanol-thiopentone-sevoflurane anaesthesia in buffaloes undergoing diaphragmatic herniorrhaphy. *Haryana Veterinarian* **59**(SI): 74–78.

Khan I, Kumar A, Singh J, Peshin P K and Singh S. 2007. Evaluation of glycopyrrolate as an anticholinergic in buffalo calves (*Bubalus bubalis*). *Italian Journal of Animal Sciences* **6**(2): 1007–10.

Kishore V, Kumar A, Chaudhary R N, Tiwari D K, Arora N, Kumar S and Jamdagni M. 2019. Evaluation of efficacy and safety of glycopyrrolate - acepromazine - butorphanol - propofol - sevoflurane anaesthesia in buffaloes undergoing diaphragmatic herniorrhaphy. *Haryana Veterinarian* **58**(1): 78–81.

Krishnamurthy D, Deshpande K S, Nigam J M, Peshin P K and Singh S C. 1980. Repair of diaphragmatic hernia in bovine – transthoracic approach. *Indian Journal of Veterinary Surgery* **1:** 7–11.

Kumar A and Sharma A K. 1986. Thiopentone sodium with and without xylazine premedication in buffaloes. *Indian Journal of Animal Sciences* **56**(10)**:** 1022-29.

Kumar A and Singh H. 1979. Ketamine and xylazine anaesthesia in bovine pediatric surgery. *Indian Veterinary Journal* **56**(3): 219–22.

Kumar Amresh, Kumar A, Singh S and Chaudhary R N. 2014a. Evaluation of midazolam-ketamine as an anaesthetic combianation in buffalo calves. *Haryana Veterinarian* **53**(2): 117–20.

Kumar Amresh, Kumar A, Singh S and Chaudhary R N. 2014b Evaluation of diazepam-ketamine as anaesthetic combination in buffalo calves. *Haryana Veterinarian* **53**(1): 58–62.

Kumar V, Singh S, Kumar A, Singh J and Peshin P K. 2011. Evaluation of propofol as an anaesthetic in buffalo (*Bubalus bubalis*) calves. *Haryana Veterinarian* **50**: 15–18.

Naik P V and Mahandale S S. 1969. A case of diaphragmatic hernia in buffalo. *Indian Veterinary Journal* **46**: 62.

Nigam J M, Singh J, Peshin P K and Singh A P. 1983. Effects of chloral hydrate and thiopental sodium on haemodynamics, acid base and blood gases in buffalo calves. *Indian Journal of Veterinary Surgery* **4**: 40–45.

Ninu A R, Tayal R, Kumar A, Behl S M and Chawla S K. 2015. Comparison of thiopentone and ketamine as induction and maintenance agents in buffaloes undergoing diaphragmatic herniorrhaphy. *Journal of Applied Animal Research* **43**(4): 462–67.

Pawde A M, Amarpal, Aithal H P, Pratap K and Bisht G S. 2000. Detomidine-diazepam-ketamine anaesthesia in buffalo (*Bubalus bubalis*) calves. *Journal of Veterinary Medicine* **47**(3): 175–79.

Peshin P K and Kumar A. 1979. Physiologic and sedative effects of xylazine in buffaloes. *Indian Veterinary Journal* **56:** 864–71.

Peshin P K, Singh A P, Singh J, Chawla S K and Lakharu J C. 1986. Acid-base and blood gas changes following xylazine administration in buffalo and camel. *Indian Journal of Animal Sciences* **56**(10): 198–202.

Potliya S. 2015. 'Evaluation of balanced anaesthetic combinations for anaesthetic management of buffaloes undergoing diaphragmatic herniorrhaphy.' Ph.D. thesis submitted to Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar, Haryana.

Potliya S, Kumar A, Kumar S, Singh S and Kumar S. 2015. Evaluation of efficacy and safety of glycopyrrolate - xylazine - propofol anaesthesia in buffalo calves. *Veterinarian World* **8**(3): 251–56.

Prasad B, Singh J, Kumar A, Sharma S N, Rathor S S and Kohli R N. 1977. Surgical repair of diaphragmatic hernia in buffaloes– an analysis of 42 cases. *Indian Veterinary Journal* **54**: 656–60.

Ramakrishna O, Krishnamurthy D and Nigam J M. 1981. Ketamine anaesthesia in buffalo calves. *Indian Veterinary Journal* **58:** 503–05.

Ratnesh, Peshin P K, Kumar A and Singh S. 2014. Effects of propofol on haematological and blood biochemical profile of buffalo calves (*Bubalus bubalis*). *Indian Journal of Veterinary Surgery* **35**(1): 25–27.

Sharma S, Tayal R, Behl S M, Chawla S K, Chaudhary R N and Pandey A K. 2015. Clinico-haemato-biochemical studies of different anaesthetic combinations in buffaloes undergoing diaphragmatic herniorrhaphy. *Haryana Veterinarian* **54**(2): 109–13.

Sharma S. 2019. 'Comparative evaluation of efficacy and safety of anaesthetic combinations of glycopyrrolate-dexmedetomidine/ xylazine-pentazocine with propofol/etomidate for induction and isoflurane/sevoflurane for maintenance in buffaloes

undergoing diaphragmatic herniorrhaphy.' Ph.D. thesis submitted to Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar.

Singh A P, Singh J, Peshin P K, Gahlawat J S, Singh P and Nigam J M. 1985. Evaluation of xylazine-ketamine anaesthesia in buffaloes (*Bubalus bubalis*). *Zentralblatt für Veterinärmedizin, Reihe A* **32:** 54–58.

Singh G D, Kinjavedkar P, Amarpal, Aithal H P, Pawde A M, Zama M M S, Singh J and Tiwary R. 2013. Clinicophysiological and haemodynamic effects of fentanyl with xylazine, medetomidine and dexmedetomidine in isoflurane-anaesthetized water buffaloes (*Bubalus bubalis). Journal of the South African Veterinary Association* **84**(1): 11.

Singh G D, Kinjavedkar P, Amarpal, Aithal H P, Pawde A M, Singh J and Malik P K. 2012. Clinicophysiological and haemodynamic effects of fentanyl with medetomidine in halothane and isoflurane anaesthetised water buffaloes (*Bubalus bubalis*). *Indian Journal of Veterinary Surgery* **33**(1): 11–15.

Singh J, Fazili M R, Chawla S K, Tayal R, Behl S M and Singh S. 2006. Current status of diaphraghmatic hernia in buffaloes with special reference to etiology and treatment: a review. *Indian Journal of Veterinary Surgery* **27**(2): 73–79.

Singh J, Prasad B, Kumar R, Kohli R N and Rathore S S. 1977. Treatment of diaphragmatic hernia in buffaloes. *Australian Veterinary Journal* **53**: 473–75.