Haryana Vet. (December, 2020) **59(2)**, 220-224

Research Article

COMPARATIVE EVALUATION OF TOTAL INTRAVENOUS ANAESTHESIA (TIVA) AND INHALATION ANAESTHESIA IN CATTLE

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Received: 27.11.2019; Accepted: 27.01.2020

ABSTRACT

The present study compared the efficacy of total intravenous anaesthesia (TIVA) with inhalation anaesthesia for maintenance of anaesthesia in twelve cattle undergoing various surgical procedures. All animals were premedicated with butorphanol 0.1 mg/kg body weight intravenously followed by induction with ketamine @ 2.0 mg/kg body weight and diazepam @ 0.1 mg/kg body weight. In group-I, total intravenous anaesthesia was maintained by the combination of ketamine @ 1 mg/kg, diazepam @ 0.05 mg/kg and butorphanol @ 0.02 mg/kg whereas in group-II, anaesthesia was maintained with isoflurane mixed with oxygen. Smooth induction and stable cardiopulmonary functions were observed in animals of both the groups. However, mild muscle relaxation was recorded in group I as compared to good muscle relaxation in group II during anaesthesia. The mean time of complete recovery recorded in group I was 116.16±7.45 minutes and 38±1.46 minutes in group II. Therefore it is concluded that maintenance of anaesthesia with isoflurane provides smooth, fast, and complication free recovery.

Keywords: Butorphanol, Cattle, Diazepam, Inhalation, Ketamine, Total intravenous anaesthesia

Current scenario of large animal surgery is more inclined towards performing major surgical procedures under general anaesthesia. The successful outcome of surgery must accommodate welfare of animal as well as its owner (farmer) with minimal or no complications post operatively. The surgical procedures in livestock are now performed using general anaesthesia by inhalation anaesthesia as well as total intravenous anaesthesia. The parentral general anaesthetics prove to be advantageous in order to reduce pain during surgical interventions and of convenience for the patient and surgeon both (Ley *et al.,* 1990).

The balanced anaesthesia necessitates combination of drugs that provide varied degree of hypnosis, sedation, unconsciousness, mayo relaxation and analgesia (Bojan *et al.*, 2014). These combinations usually include injectable anaesthetics, an alpha2 agonist, benzodiazepines and opioids. Although ketamine induces good dissociative anaesthesia with minimal cardiopulmonary depression compared to thiopentone, the potential excitement and muscle rigidity produced without preanaesthetic limits the use of ketamine alone as explained by Abrahamsen (2008).

Thus, present study was conducted to determine an appropriate combination of butorphanol, ketamine and diazepam in that would produce safe and satisfactory total intravenous anaesthesia in cattle for different surgical procedures under field conditions and to compare TIVA with inhalation anaesthesia using same protocol for sedation and induction by altering maintenance drug.

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MATERIALS AND METHODS

The study included twelve clinical cases of bovine species presented for correction of various surgical conditions. The history regarding age, sex, body weight was recorded as mentioned in Table 1.

A thorough clinical examination was conducted for all the animals and pre-anaesthetic physiologic and haematological parameters were recorded prior to the surgery. All the 12 animals were fasted 24-48 hours with 12 hours of water withholding. The anaesthetic regime included sedation of all the animals with the butorphanol @ 0.1mg/kg followed by induction of anaesthesia with combination of ketamine @ 2.0 mg/kg and diazepam 0.1mg/kg.

Further, the animals were randomly divided in to two equal groups having 6 animals in each. Anaesthesia in group I animals was maintained by total intravenous anaesthesia (TIVA) with inj. ketamine 1mg/kg, diazepam 0.05 mg/kg and butorphanol 0.02 mg/kg, whereas, in group II with isoflurane. Animals were subjected to various surgical interventions like hernia (n=2), mastectomy (n=1), knee tumour (n=1), conjunctival tumour (n=2), oesophageal obstruction (n=1), diaphragmatic hernia (n=1), tumour (n=1), caesarean section (n=2) and plating (n=1).

The clinical parameters like rectal temperature, heart rate and respiratory rate were recorded at various time intervals viz. 15, 30, 45 and 60 minutes during and after anaesthesia, whereas, haematological and biochemical

Table 1

Characteristics of the animals under study

Case no.	Age (Year)		Sex		Body weight (Kg)	
	Group I	Group II	Group I	Group II	Group I	Group II
1	5 yr	8 yr	Male	Female	390	380
2	6 m	7 yr	Female	Male	180	350
3	7 yr 6 m	4 yr	Female	Female	405	410
4	7 yr	6 m	Female	Female	415	140
5	2 yr	3 yr	Male	Female	260	190
6	2 yr	4 m	Male	Female	190	120
Average	4 yr	3.8 yr	——	——	306.66	265

parameters (pre-operative, intra-operative and post-operative) were recorded before, during and 24 hrs after anaesthesia. Anaesthetic parameters included quality of sedation, quality of induction, quality of anaesthesia and recovery were evaluated by various grading systems as per Gill (2013) mentioned in Table 2 and 3.

The results were tabulated and statistically analysed by Student t test, two sample test and paired t test as described by Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

A mild to moderate quality of sedation was produced in all animals as per the grading scale exhibiting lowering of head, shifting of weight drooping of eyelids and lack of salivation with in 10 min post intravenous administration of butorphanol @ 0.1mg/kg body weight. The animals remained calm until the induction of anaesthesia.

Table 2

Scoring scale for quality of sedation (Gill, 2013)

0	No sedation	Animal is alert and eyes open
1	Mild sedation	Drooping of eye lids, mild sensory and motor deficit
2	Moderate sedation	Drooping of eye lids, moderate sensory and motor deficit
3	Deep sedation	Drooping of eye lids, severe sensory and motor deficit

Table 3

Scoring scale for quality of Induction (Gill, 2013)

1	Poor	Obvious excitement, attempt to stand after recumbency, massive regurgitation, inability to intubate trachea.
2	Moderate	Mild excitement, mild regurgitation, longer tracheal intubation time, slightly prolonged induction
3	Good	No excitement, no regurgitation, reflex response to intubation
4	Excellent	Smooth and rapid induction, easy and quick tracheal intubation, no regurgitation

Anaesthesia was induced with the combination of ketamine @ 2mg/kg and diazepam @ 0.1mg/kg till the abolishment of all the reflexes in all the animals. The quality of induction was graded as per Table 3. In the present study, smooth, excitement free induction was recorded with absence of limb movement, absence of response to pain and that allowed easy endotracheal intubation. However, regurgitation in one animal and salivation in three animals was reported which could be attributed to inadequate fasting of these animals. Therefore, the quality induction of anaesthesia was recorded as good with score of 3.083±2.87 as per grading system by Senthilkumar *et al.* (2009).

A comparative study of maintenance of anaesthesia was further performed by dividing the animals randomly into two equal groups containing 6 animals in each where anaesthesia was maintained by TIVA with ketamine 1 mg/kg, diazepam 0.05mg/kg and butorphanol 0.02 mg/kg intravenously in group I and group II was maintained on inhalation anaesthesia using isoflurane 2-4%.

Group II showed better quality of anaesthesia with good muscle relaxation, depressed palpebral, corneal and swallowing reflexes were observed for duration of 128 minutes when compared to mild muscle relaxation and mild depression of reflexes in group I for duration of 82 minutes.

After discontinuation of the anaesthetic, mean time required for head up in lateral recumbency was 28.00 ± 2.018 and 18.83 ± 0.946 minutes, for attaining sternal recumbency 39.50 ± 2.32 and 26.67 ± 1.15 and for standing time 116.18 ± 7.46 and 38.00 ± 1.46 in group I and II, respectively.

Physiological parameters recorded before induction of anaesthesia, at 5, 15, 30, 45 and 60 minutes during

Table 4

Physiological parameters of animals at different times of anaesthesia (Mean) (n=6)

Time	Heart rate (beats/min.)		Respiration rate (breaths/min.)		Rectal temperature (°F)	
	Group I	Group II	Group I	Group II	Group I	Group II
Baseline	63.83	68.17	30.33	27.50	100.67	100.95
5 min	66.00	69.50	30.67	26.50	100.67	100.73
15 min	73.50	76.17	28.67	23.33	100.37	100.57
30 min	76.50	75.00	26.67	20.33	100.35	100.43
45 min	70.17	70.67	27.17	19.83	100.32	100.12
60 min	71.50	65.67	24.67	18.33	100.37	100.02
Recovery	75.50	71.67	29.17	25.67	100.63	100.55

anaesthesia and after complete recovery are presented in Table 4. There was non-significant difference in heart rate during maintenance of anaesthesia when compared between both groups. However, a significant increase in heart rate was observed within the groups indicative of release of catecholamines by butorphanol-ketamine-diazepam and Isoflurane that have stimulatory effect on cardiac output (Tweed *et al.,* 1972 and Greene *et al.,* 1988).

Group I showed non-significant decrease in respiration rate at different time intervals during anaesthesia whereas significant decrease in respiratory rate within group II was observed during anaesthesia. This significant decrease in mean respiratory rate in group II could be attributed to the type of surgical interventions like diaphragmatic hernia included in the group that required artificial ventilation or may be due to the respiratory depressant effect isoflurane as explained by Bodh *et al.* (2013). However, a non significant difference was observed between group I and II. A non significant difference was observed in mean rectal temperature (°F) within as well as between groups.

Haematological parameters were studied preoperatively, intra-operative and post operatively. A significant decline in haemoglobin was observed within both the groups whereas there was no significant difference in the values of haemoglobin between the groups (Table 5). A significant declining trend in TEC values was seen during maintenance of anaesthesia in animals of group I with TIVA. Whereas, there was non-significant decrease in TEC values during anaesthesia in animals of group II maintained on inhalation anaesthesia. There was significant decline in Packed Cell Volume (PCV) (%) values of group I whereas in group II, a non significant difference was recorded. All the values were within the normal physiological range. The decline in PCV and Hb during the period of anaesthesia or sedation may be due to shifting of fluid from extravascular compartment to intravascular compartment in order to maintain normal cardiac output as described by Wagner *et al.* (1990).

The mean of Total Leukocyte Count values were 12.17± 1.21/mm^3 and 9.80 ± 1.26 /mm^3 in group I and group II, respectively before surgery. A significant decrease in Total Leukocyte Count was observed within both the groups. However, there was non-significant difference in values between group I and II (Table 5).

Effect of anaesthesia on Biochemical Parameters: A significant decrease in SGPT and SGOT values was observed within group I during surgery. Whereas in group II, a non significant decrease in the values of SGPT while non-significant increase in values of SGOT were observed. Elevated baseline SGOT values were observed in both the groups and they persisted throughout the observation period (Table 6). This could be attributed to the long duration of illness and prolonged treatment regimen followed in all the cases. All the values returned near to the baseline values after 24 hrs of observation period.

A non significant increase in the values of Blood Urea Nitrogen (mg/dl) was observed in the animals of both the groups. The alterations in values were observed within group and also between groups. The mean values of Serum Creatinine (mg/dl) recorded before surgery were 1.64± 0.11 and 1.61±0.11 in Group I and II, respectively (Table 6). A significant increase in creatinine levels were observed in group-I, whereas a non significant increase was observed in animals maintained on isoflurane anaesthesia in group-II, indicative of considerable damage to skeletal muscles due to TIVA anaesthesia. There was no change in intra operative values from base levels which might be due to maintenance of renal blood flow by giving intravenous fluids. Maintenance with isoflurane is considered safe because there is minimal production of fluoride ions and

Table 5

Haematological parameters of animals at different times of anaesthesia (Mean) (n=6)

variable	Pre-operatively		Intra- operatively		Post-operatively	
	Group I	Group II	Group I	Group II	Group I	Group II
Haemoglobin (g%)	11.18±0.72	8.93±1.07	9.45±0.55	8.21 ±1.06	10.11±0.41	8.86 ±1.07
Total Erythrocyte Count (6x10/µl)	6.32±0.29	5.57±1.25	4.86±0.23	5.18±1.29	4.55±0.25	5.58±1.48
Total Leucocyte count ($x10^3$/µl)	12.16±1.02	9.8±1.26	10.66±0.84	7.76±1.09	10.53±0.90	8.90±1.22
Packed Cell Volume (%)	34.71±2.83	29.07±3.49	28.55±1.64	27.56±3.73	26.35±1.66	28.77±3.80

Paired 't' test within group I and II

		t stat for Hb	t stat for TEC	t stat for TLC	t stat for PCV
Group I	Pre-op and Intra-op	7.74^{*}	10.545^{*}	5.827^{*}	3.485^{*}
	Pre-op and Post-op	2.155^{NS}	12.778^{*}	5.598^{*}	4.398^{*}
Group II	Pre-op and Intra-op	6.290^{*}	6.205^{*}	5.674^{*}	2.403^{NS}
	Pre-op and Post-op	0.433^{NS}	-0.041^{NS}	5.553^{*}	0.328^{NS}
Student 't' test between group I and II					
	Intra-op	1.021^{NS}	-0.248^{NS}	2.094^{NS}	0.248^{NS}
	Post-op	1.081^{NS}	-0.684^{NS}	1.067^{NS}	-0.580^{NS}

Table 6

Biochemical parameters of animals at different times of anaesthesia (Mean) (n=6)

Variable	Pre-operatively		Intra- operatively		Post-operatively	
	Group I	Group II	Group I	Group II	Group I	Group II
SGPT (U/L)	24.64±3.72	26.76±3.97	22.01±3.35	26.53±3.84	23.00±3.20	25.60±4
SGOT (U/L)	178.81±18.33	190.45±17.24	163.75±16.49	190.46±16.68	177.00±19.84	190.00±17.21
BUN (mg/dl)	28.30±2.70	31.35±2.99	30.11±2.70	31.96±2.93	30.18±3.10	30.40±2.83
Creatinine (mg/dl)	1.64±0.11	1.61±0.11	1.82±0.14	1.50±0.12	1.91±0.14	1.53±0.13

Paired 't' test within group I and II

		t stat for SGPT	t stat for SGPT	t stat for BUN	t stat for Creatinine
Group I	Pre-op and Intra-op	3.572*	4.429*	-1.783^{NS}	-2.906^{NS}
	Pre-op and Post-op	1.640^{NS}	0.597^{NS}	-1.420^{NS}	-4.340*
Group II	Pre-op and Intra-op	0.378^{NS}	-0.005^{NS}	-1.821^{NS}	2.349^{NS}
	Pre-op and Post-op	1.510^{NS}	0.292^{NS}	1.512^{NS}	1.643^{NS}
Student 't' test between group I and II					
	Intra-op	-0.880^{NS}	-1.139^{NS}	-0.46^{NS}	1.732^{NS}
	Post-op	-0.501^{NS}	-0.498^{NS}	-0.059^{NS}	1.887^{NS}

less than 1% elimination through kidney (Buttar, 2014).

CONCLUSION

It can be concluded that Butorphanol-Diazepam-Ketamine combination can be used for total intravenous anaesthesia for surgical procedures less than 60 minutes in cattle without any side effects on hepatic or renal as well as cardiovascular system under field conditions where the monitoring facilities are meager. Further, maintenance of anaesthesia using inhalation provides very safe anaesthesia for longer durations followed by smooth and rapid recovery in short duration of procedure without any complication when compared with TIVA technique of anaesthesia using BDK combination.

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