DOI : 10.5958/2277-8934.2024.00053.9 *Vol 31 No 3, p 275-283*

CLINICO-PHYSIOHAEMODYNAMIC AND HAEMATO-BIOCHEMICAL EVALUATION OF DEXMEDETOMIDINE IN COMBINATION WITH BUTORPHANOL AND KETAMINE ANAESTHESIA IN CAMELS (*Camelus dromedarius*)

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ABSTRACT

The study was conducted to evaluate the preanaesthetic effects of two doses of dexmedetomidine (2.5 µgm kg^{-1} and 4 µgm kg^{-1}) in combination with butorphanol (0.05 mg Kg^{-1}) and ketamine HCl (2 mg Kg^{-1}) administered intravenously in camels. Prospective randomised crossover experimental trials were conducted in 6 camels divided in two groups (n=6): D1BK and D2BK based on the dose of dexmedetomidine 2.5 µgm kg^{-1} and 4 µgm kg^{-1}, respectively. Clinico-physiological parameters were recorded at T 0 (pre-administration), at induction T -I as well as at T- 15, 30, 45, 60, 90, 120 and T- 180 minutes post-administration. Haemato-biochemical parameters were recorded at 0 min (pre-administration) and at induction T- I, at T- 30, 60, 120 as well as T- 180 minutes post-administration. All data were statistically analysed. The results revealed that the induction of anaesthesia was quicker in D2BK group (0.99± 0.02 min) than that in D1BK group (1.03 ± 0.020 min). The duration of anaesthesia, recovery time and complete recovery time 62.71 ± 2.07, 63.71± 2.08 and 93.59 ± 1.63 min, respectively were significantly ($P<0.01$) longer in D2BK group 44.61±1.37, 45.64 ± 1.37 and 71.08 ± 2.38 min, respectively than those in D1BK group. The quality of anaesthesia and degree of analgesia were significantly better ($P<0.05$) in D2BK group than those in D1BK group. Rectal temperature and blood pressure showed non-significant changes at different time intervals in both groups ($P>0.05$). Respiration rate decreased significantly ($P<0.05$) in D2BK group. Heart rate and pulse rate decreased significantly ($P<0.05$) in both D1BK and D2BK groups. Haemato- biochemical parameters showed non-significant variations during the period of study within the group and between the groups at different time intervals ($P>0.05$). In conclusion, dexmedetomidine is a clinically useful and safe to be employed as pre-anaesthetic drug in combination with butorphanol- ketamine anaesthesia in camels.

Key words: Anaesthesia, butorphanol, camel, dexmedetomidine, ketamine, preanaesthetic

In India dromedary camel is reared primarily for carting, draught, agricultural operation and transportation therefore, these are more prone to various injuries and surgical disorders, hence requires good anaesthesia to carry out any surgical interventions. Use of preanaesthetic prior to induction of anaesthesia improves the quality of anaesthesia and also reduces the adverse effect of individual anaesthetic agent. Dexmedetomidine is a new generation potent alpha-2 adrenoceptor agonist with the highest affinity for alpha-2 adrenoceptor, allowing its application in relatively high doses for sedation and analgesia without the unwanted vascular effects resulting from stimulation of α1 receptors (Ebert *et al,* 2000; Kuusela *et al,* 2001). Studies on safe sedative combination of dexmedetomidine, ketamine and butorphanol for minor procedures in dogs have been done (Imboden *et al,* 2023). Opoids are the most commonly used analgesics to supplement anaesthetics as they have synergistic effect with the alpha-2 agonist (Chabot-Dore *et al,* 2015). Butorphanol is a synthetically derived opioid agonist-antagonist analgesic of the phenanthrene series, with a potency of about 4 to 7 times that of morphine (Bush *et al,* 2011). It provides analgesia and mild sedation but does not depress respiratory and cardiovascular function unless high dose rates are used (Muir, 1998). Medetomidine-ketamine and medetomidine-ketamine-butorphanol combinations were used for the field anaesthesia of free-ranging dromedary

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camels (*Camelus dromedarius*) in Australia (Boardman *et al,* 2014). Sedative, analgesic, behavioural and clinical effects of intravenous nalbuphine-xylazine combination in camels were also studied previously (Khalil *et al,* 2019). Ketamine butorphanol (Nath *et el,* 2024) and ketamine, diazepam and butorphanol were used as total intravenous anesthesia in camels (Almubarak, 2012). Premedication, sedation and adequate anaesthetics were suggested for camels in field conditions. In new previous studies, it is imperative to find a combination of preanaesthetics and anaesthetics which can provide satisfactory anaesthesia and muscle relaxation in camels. The present study was therefore, aimed to investigate pre-anaesthetic effects of two doses different of dexmedetomidine in combination with butorphanol and ketamine HCl anaesthesia in dromedary camels.

Materials and Methods

The experimental protocol was approved by the institutional ethics committee of National Research Centre on Camel (ICAR) Bikaner, India. Six adult healthy male camels with a mean body weight of 435.38 ± 11.22 kg and aged 4-5 years were selected and managed under uniform feeding and managemental conditions. All camels were used in a randomised crossover design with an interval of 14 days between two treatments on same animal. Food and water were withheld for 24 and 12 hours, respectively prior to the experiment. The experiment was performed outdoors in a quiet environmental condition. Camels were kept restrained in sitting position/sternal recumbency with both fore limbs tied together and allowed for 15 minutes to be stabilised after restraining.

The preanaesthetic effect of two doses of dexmedetomidine[1] (2.5 µgm kg^{-1} b.wt and 4.0 µgm kg^{-1} b.wt) were evaluated in combination with butorphanol[2] (0.05 mg Kg^{-1}) and ketamine HCl[3] (2 mg Kg^{-1}) in two groups (n=6 in each group); D1BK and D2BK. The dose of dexmedetomidine was standardised and selected after conducting pilot trials. Dexmedetomidine was administered intravenously 10 minutes prior to the intravenous administration of butorphanol and ketamine HCl in each group. The dose of butorphanol and ketamine HCl were selected based on earlier studies (Boardman *et al,* 2014: Ahmed *et al,* 2015).

1. Dexmedetomidine - Dextomid (200mcg/ml), Neon Laboratories Ltd. andheri (East), Mumbai, India – 400093
2. Butorphanol- Butodol (2mg/ml) Neon Laboratories Ltd. andheri (East), Mumbai, India – 400093
3. Ketamine – Aneket ((50mg/ml), Neon Laboratories Ltd. andheri (East), Mumbai, India – 400093)

Anaesthesia was evaluated by subjective assessment of median scores of various reflexes. These reflexes including relaxation of jaw, palpebral reflex, response to intubation, response to pin prick and bone prick as well as pedal reflex were recorded at T-0 minute (pre-administration), at induction T –I, at T-15, 30, 45, 60, 90, 120 and 180 minutes post-administration of dexmedetomidine, butorphanol and ketamine. Quality of anaesthesia was evaluated by observing behavioural response of camel for various reflexes based on a 0 to 3 scoring scale *viz*. (0): intact (1): mild response; (2): moderate response; (3): good response (Singh *et al,* 2013) (Table 1).

The physio-haemodynamic parameters including rectal temperature (RT), respiration rate (RR), heart rate (HR), pulse rate (PR), systolic and diastolic blood pressure (SBP and DBP) were recorded at T-0 minute (pre administration), at T- I (induction), T-15, 30, 45, 60, 90 and 120 and 180 minutes post-administration of dexmedetomidine, butorphanol and ketamine.

Haemato-biochemical parameters were studied in blood sample collected at T-0 minute (pre administration) and at induction T-I, at T-30, 60, 120 and 120 minutes post-administration of dexmedetomidine butorphanol and ketamine. Haematological parameters *viz*. haemoglobin (Hb), packed cell volume (PCV), total leucocyte count (TLC), total erythrocyte count (TEC), differential leucocyte count (DLC) were estimated using automated haemato-analyser (IDEXX Vet Test, IDEXX Laboratories Inc. Westbrook United State). Biochemical parameters *viz*. glucose, alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALKP), serum urea nitrogen (SUN) and creatinine were estimated with the help of semi-auto analyser (LT -100, Labtech Healthcare India Pvt Ltd) using commercial kits. The cortisol level (µg/dL) as a stress marker hormone was estimated using cortisol ELISA kits.

Statistical analysis

The data were presented as mean ± standard error of mean and median (Range) in parametric and non parametric statistical analysis, respectively by using SPSS software version 20 (IBM SPSS Statistics 20). Analysis of Variance (ANOVA) and Duncan's multiple range test (DMRT) were used to compare the means at different time intervals among groups and paired t test was used to compare the means at different time interval with respective base values (Snedecor and Cochran, 1994). The subjective data

generated from the sedation scores were analysed using non parametric Kruskal- Wallis test. A value of $P < 0.05$ was considered significant.

Results and Discussion

The induction of anaesthesia in D2BK group (0.99 ± 0.02 min) was earlier than that of D1BK group (1.03 ± 0.020 min). The duration of anaesthesia, recovery time and complete recovery time were significantly (P<0.01) prolonged in D2BK 62.71 ± 2.07 min, 63.71 ± 2.08 and 93.59 ± 1.63 min, respectively than those of the D1BK group 44.61±1.37, 45.64 ± 1.37 and 25.85 ±0.97 min and 71.08 ± 2.38 min, respectively (Fig 1).

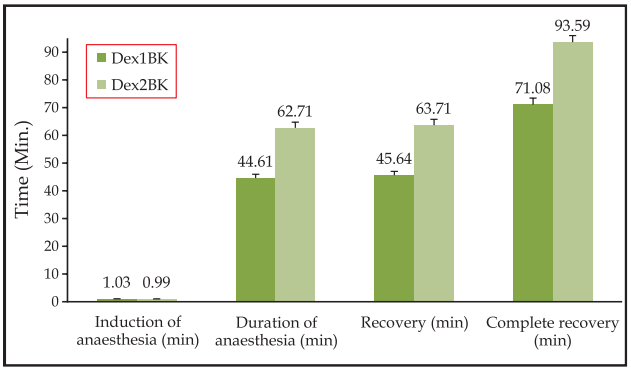

Fig 1. Induction, duration, recovery and complete recovery from dexmedetomidine, butorphanol and ketamine HCl anaesthesia in camels.

Good jaw relaxation was recorded in both D1BK and D2BK groups at induction but jaw tone appeared early in the D1BK group. Jaw relaxation score was significantly high (P<0.05) in D2BK group compared to that seen in the D1BK group particularly at 60, 90 and 120 min time interval (Table 2). Very weak to no palpebral reflex was recorded at induction of anaesthesia and up to 30 min interval in D1BK, whereas, no palpebral reflex was recorded at induction of anaesthesia and up to 45 min interval in D2BK group. The palpebral reflex score was significantly higher (P<0.05) at 60 min in

Table 1. Numeric scoring system used for used for recording of various reflexes and response.

Parameters	Scale			
	0	1	2	3
Jaw relaxation	Not allowing opening the jaws	Resistant to open the jaw and closed quickly	Less resistance to open the jaw and closed quickly	No resistance and jaw remain open
Palpebral reflex	Intact and strong reflex (quick blink)	Intact and strong reflex (slow response)	Very weak reflex (occasional response)	Abolished reflex (No response)
Intubation	Not permitting entry of tube in mouth	Allow entry but chewing	Difficult intubation	Easy intubation
Pedal reflex	Intact and strong refax (strong withdrawal)	Intact but weak reflex (slow response)	Intact but very light reflex (slow and occasional response)	Reflex abolished
Response to bone prick pin prick	Strong reaction (strong withdrawal)	Weak reaction (slow response)	Slow and occasional response	No reaction

Table 2. Median value of jaw relaxation, palpebral reflex, intubation, pedal reflex and pin prick in camels of different groups.

Parameters	Groups	Time intervals								
		0	I	15	30	45	60	90	120	180
Jaw relaxation	D1BK	0^{aA}	3^{bA}	3^{bA}	3^{bA}	3^{bA}	2^{abA}	1^{abA}	0^{aA}	0^{aA}
	D2BK	0^{a}	3^{bA}	3^{bA}	3^{bA}	3^{bA}	3^{bB}	1.5^{abB}	1^{abAB}	0^{aA}
Palpebral reflex	D1BK	0^{aA}	2.5^{bA}	2.5^{bA}	2.5^{bA}	2^{abA}	1.5^{abA}	1^{abA}	0^{aA}	0^{aA}
	D2BK	0^{aA}	3^{bA}	3^{bA}	3^{bA}	3^{bA}	2.5^{bB}	1.5^{abA}	1^{abB}	0^{aA}
Intubation	D1BK	0^{aA}	3^{bA}	3^{bA}	3^{bA}	3^{bA}	1^{abA}	1^{abA}	0^{aA}	0^{aA}
	D2BK	0^{aA}	3^{bA}	3^{bA}	3^{bA}	3^{bA}	3^{abB}	1^{abA}	0^{aA}	0^{aA}
Pedal reflex	D1BK	0^{aA}	3^{bA}	3^{bA}	3^{bA}	2^{abA}	1^{abA}	1^{abA}	0^{aA}	0^{aA}
	D2BK	0^{aA}	3^{bA}	3^{bA}	3^{bA}	3^{bB}	3^{abB}	1.5^{abA}	0^{aA}	0^{aA}
Pin prick	D1BK	0^{aA}	3^{bA}	3^{bA}	3^{bA}	$2.5a^{bA}$	1.5^{abA}	0^{aA}	0^{aA}	0^{aA}
	D2BK	0^{aA}	3^{bA}	3^{bA}	3^{bA}	3^{bA}	3^{abB}	2^{abB}	0^{aA}	0^{aA}

Variables with different superscript small letters differ significantly (P<0.05) within group
Variables with different superscript capital letters differ significantly (P<0.05) among different groups

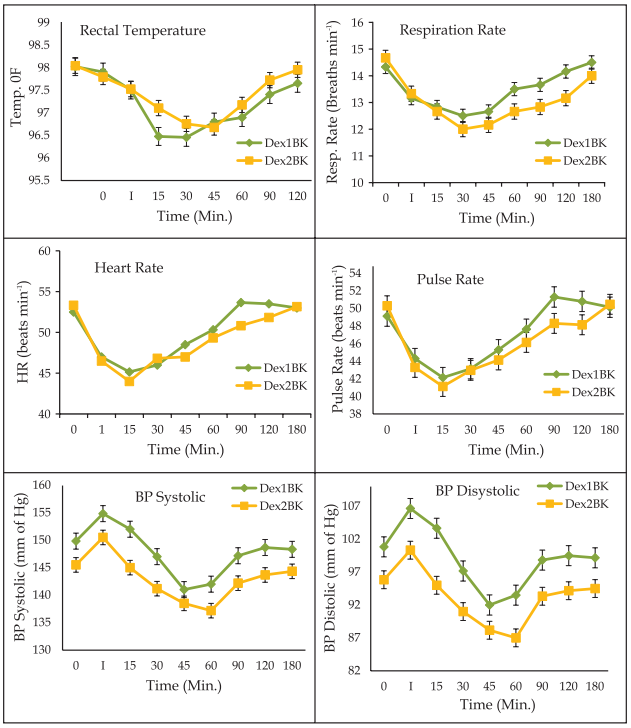

Fig 2. Physio-haemodynamic parameters in camels of D1BK and D2BK groups.

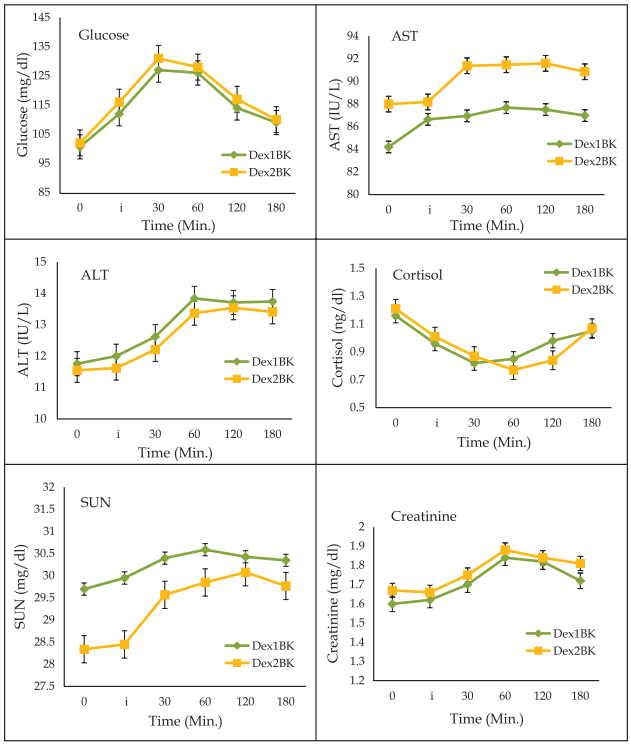

Fig 3. Biochemical parameters in camels of D1BK and D2BK groups.
AST: Aspartate aminotransferase, ALT: Alanine transaminase, ALP: Alkaline phosphatase, SUN: Serum urea nitrogen

D2BK group than that in the D1BK group (Table 2). Easy intubation without coughing could be done at induction of anaesthesia in all the animals of both D1BK and D2BK groups. Pedal reflex was abolished at induction of anaesthesia and remained so up to 30 min in D1BK group and up to 60 min in D2BK group. Significantly higher ($P<0.05$) pedal reflex score was recorded, respectively at 45 and 60 min in D2BK and D1BK groups (Table 2). Good degree of analgesia was recorded in both groups at induction but significantly higher ($P<0.05$) degree of analgesia was observed at 60 and 90 min in D2BK group than that recorded in the D1BK group (Table 2).

Early induction and prolonged duration of anaesthesia recorded in D2BK group might be attributed to the higher dose of dexmedetomidine in D2BK. Dose dependent duration of anaesthesia and recovery from anaesthesia in camels of D2BK group are well corroborated with the observations of Kuusela *et al* (2001) in dogs where significantly prolonged recovery time was recorded with a higher dose level of dexmedetomidine. Similarly, shorter weak time, down time and longer recovery time have also been reported at higher doses of dexmedetomidine in dogs (Santosh *et al*, 2012)

The combined effect of dexmedetomidine, butorphanol and ketamine caused good jaw muscles relaxation, depressed palpebral reflex and easy intubation in camels. This is well articulated with the fact that alpha 2 -agonists produce profound muscle relaxation when used alone or in combination with opioids (Ahmad *et al*, 2011) and Ketamine HCl (Ko *et al*, 2000). Alpha-2 agonists cause muscle relaxation by inhibition of alpha-2 adrenoceptors in the spinal cord (Branson *et al*, 1993). Pedal reflex in the present study is attributed to the increased nociceptive threshold due to combined effects of dexmedetomidine, butorphanol and ketamine HCl. Dose dependent analgesic effect of dexmedetomidine is mediated spinally (Hayashi *et al*, 1995) as it inhibits the release of substance P from the dorsal horn of the spinal cord (Savola *et al*, 1991). The analgesic property of ketamine HCl reduces sensitisation of pain pathways and leads to better pain control (Kee *et al*, 1997). Antinociceptive effect of butorphanol is due to partial agonist effects and mu receptor involvement (Garner *et al*, 1997).

Rectal temperature decreased non-significantly up to 45 and 60 min, respectively in D1BK and D2BK groups. Differences in RT were non-significant among groups (Table 3). Decrease in RT in both groups might be attributed to reduction in muscular activity, decrease in metabolic rate, muscle relaxation along

with depression of thermo regulatory system. Alpha-2 adrenergic agonist has been reported to induce prolonged depression of thermoregulation. (Ponder and Clarke, 1980). Decreased rectal temperauare has also been reported after midazolam, ketamine puke rate (PR), butorphanol with dexmedetomidine in dogs (Santosh *et al,* 2013) and dexmedetomidine in uraemic goats (Kumar *et al,* 2013).

Respiration rate (RR) decreased non-significantly in D1BK group whereas, in D2BK group RR decreased significantly (P<0.05) at 15, 30, 45, 60 and 90 min compared to base line thereafter increased non-significantly. Differences in RR were non-significant among groups (Table 3). Decrease in repialistion rate might be due to depression of respiratory centres through stimulation of supra-spinal adrenoceptors following systemic administration of the Alpha 2 agonist drug (Prado *et al,* 1999) and/or depressing action on respiratory center in central nervous system (Hall *et al,* 2001). Significant respiratory depressant effect in D2BK group receiving a higher dose of dexmedetomidine is well articulated with the findings of Ahmad *et al* (2011) in dogs. Non-significant variation in RR observed in D1BK group is in accordance with the dose dependent effect of dexmedetomidine seen in dogs (Sabbe *et al,* 1994).

In both D1BK and D2BK groups heart rate (HR) and PR decreased significantly (P<0.05) at 15 min and thereafter, heart rate and pulse rate increased non-significantly. Differences in HR and PR were non-significant among groups (Table 3). Bradycardia is a common effect of administration of alpha-2 agonists and ketamine as a result of reflex vagal activity and alpha-2 mediated decrease in norepinephrine release from CNS leading to inhibition of sympathetic tone (Selmi *et al,* 2004). Ketamine HCl usually stimulates the cardiovascular function causing increase in HR and blood pressure (Kumar *et al,* 2014). The dexmedetomidine countered the cardiovascular effect of ketamine. Alpha-2 agonist-induced vasoconstriction and direct increase in the release of acetylcholine from parasympathetic nerves in the heart might be responsible for bradycardia (MacDonald and Virtanen, 1992) Similarly significant bradycardia had also been reported following dexmedetomidine, ketamine and opioid administration in dogs (Balreta *et al,* 2011) and after

Table 3. Mean±SE values of physio-haemodynamic parameters in camels of both the groups.

Parameters	Groups	Time intervals								
		0	I	15	30	45	60	90	120	180
Rectal Temperature (°F)	D1BK	98.03 ± 0.50	97.91 ± 0.49	97.51 ± 0.53	96.48 ± 0.45	96.46 ± 0.53	96.80 ± 0.42	96.90 ± 0.45	97.41 ± 0.50	97.66 ± 0.50
	D2BK	98.05 ± 0.43	97.80 ± 0.40	97.53 ± 0.38	97.11 ± 0.33	96.76 ± 0.35	96.68 ± 0.25	97.18 ± 0.26	97.73 ± 0.40	97.96 ± 0.36
Respiration Rate (Breaths min^{-1})	D1BK	14.33^{abA} ± 0.55	13.16^{abA} ± 0.47	12.83^{abA} ± 0.70	12.50^{aA} ± 0.71	12.66^{abA} ± 0.71	13.50^{abA} ± 0.56	13.66^{abA} ± 0.49	14.16^{abA} ± 0.30	14.50^{bA} ± 0.42
	D2BK	14.67^{bA} ± 0.42	13.33^{abA} ± 0.66	12.66^{aA} ± 0.49	12.00^{aA} ± 0.71	12.16^{aA} ± 0.51	12.66^{aA} ± 0.65	12.83^{aA} ± 0.71	13.16^{abA} ± 0.60	14.00^{abA} ± 0.48
Heart rate (beats min^{-1})	D1BK	52.5^{bcA} ± 2.47	47.0^{abcA} ± 2.11	45.16^{aA} ± 2.02	46.0^{abA} ± 2.26	48.5^{abcA} ± 1.89	50.33^{abcA} ± 2.07	53.66^{cA} ± 2.29	53.5^{cA} ± 1.91	53.0^{cA} ± 2.30
	D2BK	53.33^{bA} ± 2.29	46.5^{abA} ± 1.91	44.0^{aA} ± 2.30	46.83^{abA} ± 2.56	47.0^{abA} ± 2.18	49.33^{abA} ± 1.98	50.83^{abA} ± 1.85	51.83^{bA} ± 2.08	53.16^{bA} ± 2.09
Pulse rate (beats min^{-1})	D1BK	$49.16b^{cA}$ ±2.56	44.33^{abcA} ± 2.26	42.17^{aA} ± 1.85	43.17^{abcA} ± 2.21	45.33^{abcdA} ± 1.74	47.67^{abcA} ± 2.06	51.16^{cA} ± 2.38	51^{cA} ± 2.06	50.17^{cA} ± 2.1
	D2BK	50.33^{bA} ± 2.33	43.67^{abA} ± 2.33	41.16^{aA} ± 1.88	43^{abA} ± 1.85	44.33^{abcA} ± 2.04	46.33^{abA} ± 2.07	48.33^{bA} ± 1.81	48.5^{bA} ± 2.27	50.33^{bA} ± 2.59
Blood pressure systolic (mm Hg)	D1BK	149.83 ± 6.34	160.16 ± 6.26	163.5 ± 6.55	153.67 ± 6.55	150.16 ± 5.79	147.16 ± 5.43	146.33 ± 5.32	147.66 ± 5.43	148.66 ± 5.95
	D2BK	145.5 ± 6.03	156.66 ± 6.70	159.83 ± 7.62	151.83 ± 5.71	146.66 ± 6.10	141.16 ± 5.91	143.16 ± 4.85	145.16 ± 5.56	145.0 ± 5.31
Blood pressure Diastolic (mm Hg)	D1BK	100.83 ± 4.35	110.16 ± 6.05	113.16 ± 6.69	103.83 ± 5.44	101.0 ± 5.79	97.5 ± 4.74	97.0 ± 4.94	97.33 ± 4.57	98 .5 ± 5.11
	D2BK	95.83 ± 5.61	107.66 ± 6.24	109.66 ± 7.77	101.0 ± 5.5	97.0 ± 5.85	94.16 ± 5.31	93.33 ± 4.77	95.0 ± 5.60	95.16 ± 5.1

[a,b,c] Values bearing different superscripts differ significantly (P<0.05) within groups.
[AB] Values bearing different superscripts differ significantly (P<0.05) among different groups.

administration of xylazine HCl and dexmedetomidine in camel calves (Samimi *et al,* 2020). Butorphanol has also been reported to cause mild lowering of HR with minimum cardiovascular effects (Greene *et al,* 1990)

Systolic and diastolic blood pressure increased initially at 15 min interval in both D1BK and D2BK groups and later followed decreasing trend (Table 3). The initial increase the SBP and DBP followed by a decrease in both groups is similar to previous reports following administration of dexmedetomidine along with propofol in dogs (Singh *et al,* 2020). This biphasic effect on arterial blood pressure, with an initial rise in blood pressure followed by subsequent reduction in blood pressure might be attributed to combined effect of dexmedetomidine and ketamine, alpha-2 agonists causes initial vasoconstriction and increased blood pressure mediated by the α2 b-subtype adrenoceptors and later causes decreased sympathetic tone and low blood pressure (Kamibayashi and Maze, 2000). The sympatho-mimetic action of ketamine also elevates arterial blood pressure (Kumar *et al,* 2014)

In the present study, complete blood count values remained within the normal clinical range in both groups of camels however, non-significant changes were observed at different time periods. Hb, PCV, TEC and TLC decreased non-significantly in both the groups. DLC values fluctuated within the normal clinical range throughout the period of observations in both D1BK and D2BK groups (Table 4). The decrease in Hb, PCV, TEC and TLC values during the period of sedation could be attributed to shifting of body fluid from extravascular compartment to intravascular compartment in order to maintain normal cardiac output in the animals (Wagner *et al,* 1991). Pooling of circulatory blood cells in the spleen or other reservoirs secondary to decreased sympathetic activity might also have attributed the decrease in Hb, erythrocyte, PCV and TLC (Wagner *et al,* 1991). Decrease in Hb and PCV have also been reported after administration of xylazine, butorphanol and ketamine HCl combination in dogs (Sika, 2013). The initial increase in neutrophils and a corresponding decrease in lymphocytes recorded in the present study may be associated with initial excitement due to handling of the animals and stress caused by preanaesthetic drug and subsequent stimulation release of epinephrine leading to the release of neutrophils from bone marrow (Rosin, 1981). Similar findings have also been reported following administration of dexmedetomidine in dogs (Ahmad *et al,* 2011).

In both D1BK and D2BK groups, the blood glucose increased non-significantly up to 60 and 120 min, respectively. Later on, the values decreased but remained above base line in both groups (Table 5). Increase in blood glucose level observed in both

Table 4. Mean ±SE values of haematological parameters in camels of D1BK and D2BK groups.

Parameters	Groups	Time intervals					
		0	I	30	60	120	180
HB (gm/dl)	D1BK	12.70 ± 0.42	12.51 ± 0.45	12.30 ± 0.46	12.15 ± 0.43	12.20 ± 0.43	12.25 ± 0.35
	D2BK	12.86 ± 0.31	12.85 ± 0.37	12.38 ± 0.37	12.21 ± 0.39	12.13 ± 0.40	12.31 ± 0.31
TEC ($x10^6$ cu. mm^{-1})	D1BK	8.00 ± 0.38	7.83 ± 0.42	7.50 ± 0.40	7.42 ± 0.40	7.61 ± 0.42	7.64± 0.37
	D2BK	7.83 ± 0.46	7.69 ± 0.47	7.55 ± 0.43	7.50 ± 0.42	7.36 ± 0.44	7.45 ± 0.42
TLC ($X10^3$ cu. mm^{-1})	D1BK	13.75 ± 0.36	13.72 ± 0.30	13.57 ± 0.32	13.32 ± 0.41	13.38 ± 0.41	13.50 ± 0.34
	D2BK	13.51 ± 0.34	13.44 ± 0.30	13.36 ± 0.26	13.14 ± 0.33	13.13 ± 0.28	13.32 ± 0.32
PCV (%)	D1BK	28.15 ± 1.70	28.08 ± 1.65	26.67 ± 1.39	25.7 ± 1.242	26.77 ± 1.671	27.62 ± 1.50
	D2BK	27.45 ± 1.64	27.23 ± 1.53	25.8 ± 1.32	24.38 ± 1.16	25.35 ± 1.219	26.42 ± 1.29
DLC							
Neutrophills (%)	D1BK	51.50 ± 1.05	51.83 ± 0.70	52.5 ± 0.67	52.33 ± 0.88	52.50± 1.33	52.00± 0.63
	D2BK	52.00 ± 1.41	52.33 ± 0.76	53.50 ± 0.76	54.00 ± 0.73	52.33 ± 1.20	52.17 ± 1.13
Lymphocyte (%)	D1BK	42.67 ± 1.17	42.33 ± 0.95	42.00 ± 0.85	42.33 ± 0.88	41.83 ± 1.24	42.33 ± 0.66
	D2BK	41.17 ± 1.75	41.5 ± 1.14	40.17 ± 1.24	40.00 ± 0.68	41.33 ± 1.28	42.00 ± 1.12
Monocyte (%)	D1BK	3.33 ± 0.33	3.16 ± 0.47	2.66 ± 0.21	2.50 ± 0.22	3.50 ± 0.56	3.00 ± 0.25
	D2BK	4.16 ± 0.30	3.83 ± 0.54	3.66 ± 0.33	4.00 ± 0.25	4.33 ± 0.33	3.66 ± 0.33
Eocinophills (%)	D1BK	2.50 ± 0.42	2.67 ± 0.42	2.83 ± 0.60	2.83 ± 0.54	2.17 ± 0.30	2.83 ± 0.47
	D2BK	2.67 ± 0.42	2.33 ± 0.33	2.67 ± 0.33	2.00 ± 0.36	2.00 ± 0.20	2.17 ± 0.40

HB; Haemoglobin, TEC: Total erythrocyte count, TLC: Total leucocyte count, PCV: Packed cell volume

Table 5. Mean±SE values of biochemical parameters in camels of D1Bk and D2BK groups.

Parameters	Groups	Time intervals					
		0	I	30	60	120	180
Blood glucose (gm/dl)	D1BK	100.66 ± 7.57	109.16 ± 8.0	123.83 ± 8.31	125.66 ± 9.15	115.5 ± 7.02	111.83 ± 6.87
	D2BK	103.0 ± 8.94	112.0 ± 9.61	119.16 ± 8.78	124.0 ± 8.96	127.67± 59.97	114.66 ± 18.41
AST (IU/L)	D1BK	84.2 ± 4.56	86.64 ±5.21	86.95 ±5.10	87.68 ±5.1	87.51 ± 5.03	86.98 ± 4.88
	D2BK	87.99 ± 5.88	88.18 ± 6.04	91.38 ± 5.63	91.47 ± 4.57	91.60 ± 5.32	90.85 ± 5.09
ALT (IU/L)	D1BK	11.76 ± 0.77	12.00 ± 0.80	12.62 ± 0.64	13.84 ± 0.75	13.71 ± 0.76	13.74 ± 0.77
	D2BK	11.55 ± 0.73	11.62 ± 0.73	12.21 ± 0.77	13.37 ± 0.85	13.54 ± 0.75	13.41 ± 0.76
ALP (IU/L)	D1BK	94.5 ± 5.69	94.67 ± 6.79	95.5 ± 5.82	97.5 ± 6.44	96.66 ± 5.99	95.5 ± 6.17
	D2BK	93.67 ± 5.41	94.5 ± 5.39	95.83 ± 5.39	97.66 ± 4.5	96.16 ± 4.16	95.0 ± 5.34
SUN (mg/dl)	D1BK	29.70 ± 1.57	29.95 ± 1.47	30.40 ± 1.75	30.59 ± 1.45	30.43 ± 1.01	30.35 ± 1.50
	D2BK	28.34 ± 1.23	28.45 ± 1.38	29.57 ± 1.37	29.85 ± 1.02	30.08 ± 1.45	29.77 ± 1.22
Creatinine (mg/dl)	D1BK	1.09 ± 0.14	1.12 ± 0.11	1.18 ± 0.11	1.23 ± 0.10	1.26 ± 0.09	1.21 ± 0.12
	D2BK	1.01 ± 0.12	1.03 ± 0.13	1.15 ± 0.13	1.24 ± 0.10	1.25 ± 0.10	1.22± 0.11
Cortisol (µg/dL)	D1BK	1.16 ± 0.11	0.96 ± 0.09	0.82 ± 0.09	0.85 ± 0.10	0.98 ± 0.08	1.05 ± 0.11
	D2BK	1.21 ± 0.11	1.01 ± 0.10	0.87± 0.07	0.77 ± 0.07	0.84 ± 0.09	1.07± 0.08

AST: Aspartate aminotransferase, ALT: Alanine transaminase, ALP: Alkaline phosphatase, SUN: Serum urea nitrogen

groups might be attributed to increased hepatic glucose production, decreased glucose utilisation by body cells, decreased membrane transport and reduced insulin plasma concentrations which are mediated by activation of α2-adrenoceptors present in the β-cells of pancreatic islets exerting a negative control of basal insulin release (Burton *et al,* 1997). Increased blood glucose had been reported following administration of dexmedetomidine, butorphanol and ketamine in dogs (Verma *et al,* 2018). A non-significant increase was observed in AST, ALT and ALKP activity up to 60 min in both D1BK and D2BK groups. Thereafter, values decreased but remained above base line in both the groups (Table 5). Transient increase in ALT, AST and ALKP levels might be associated with increased cell membrane permeability in response to haemodynamic changes induced by anaesthetic agents as result of oxidative transformation of these drugs in the liver during the process of elimination (Verma *et al,* 2018). A non-significant increase was observed in SUN and creatinine levels up to 60 min in both groups then, followed decreasing trend but remained above base line value. The increase in SUN and creatinine values in the present study might be attributed to the temporary inhibitory effects of anaesthetic drugs on the renal blood flow and consequent decrease in glomerular filtration rate and increased urea production in liver (Kinjavdekar *et al,* 2000). Increased SUN and creatinine levels have also been reported following xylazine and propofol anaesthesia in dogs (Surbhi *et al,* 2010) and dexmedetomidine, butorphanol and ketamine in dogs (Verma *et al,* 2018).

A non-significant decrease was observed in cortisol level up to 60 min in both D1BK and D2BK groups, later on followed increasing trend (Table 5). Decrease in the level of cortisol in both groups might be attributed to direct inhibitory neuroendocrine response or indirect sedative and analgesic properties of dexmedetomidine which obtund the stress response when administered systemically as evidenced in a previous study (Raekallio *et al,* 2005). Alpha-2 agonists have been reported to influence the pituitary response and may decrease adrenocorticotropic hormone output (Masala *et al,* 1985). Similarly, decreased cortisol level has also been reported following dexmedetomidine with etomidate and sevoflurane administration in dogs (Bisht *et al,* 2018).

Based on the present study, it is concluded that 4 µg/kg b.wt dexmedetomidine along with butorphanol and ketamine resulted in quicker induction, better anaesthesia of prolong duration with better analgesia than 2.5 µg/kg b.wt dexmedetomidine, butorphanol and ketamine without alarming changes in physio-haemodynamic and haemato-biochemical profiles. However, dexmedetomidine at a dose of 2.5 µg/kg b.wt with butorphanol and ketamine showed good analgesia and anaesthesia and can be used for shorter period procedures.

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