

Kingdom of Saudi Arabia
Ministry of Higher Education
King Faisal University
Deanship of Scientific Research



السعودية العربية المملكة
العلي التعليم وزارة
فيصل الملك جامعة

.١ :
- :
- :

. :

.٣ :
- :
- :
- // :
- :

% % % % % % %

. :
- :
- :

. :
// : :
..... :

Final Report

Title of Project : Effects of E. coli Endotoxin Injection on Some
Biochemical Parameters in Plasma of Camels

Investigators :

1. Abdulla M. AL-Dughaym
2. Ali Fadelmolla

Supported by :

Deanship of Scientific Research, King Faisal University

Date :

10.10.1425

Contents

1. Introduction
2. Literature Review
3. Materials and Methods
4. Results
5. Discussion
6. References

1. Introduction

Information on the effect of endotoxin on Camel is Lacking. There is a marked species differences both in sensitivity of animals to endotoxin and the dose of endotoxin which lethal (Schrawen and Houvenghel 1985). The objective of this study is to investigate the effects of administration of endotoxin on biochemical parameters in plasma of camel .

2. Literature Review

Recent experimental findings indicate that endotoxin interacts with specific membrane receptors localized on mononuclear phagocytic cells and neutrophils (Olson *et al* 1995) . Binding of endotoxin to these cells together with endotoxin – induced activation of host vascular endothelium , initiates a series of signal transduction events that culminate in release of numerous biochemical mediators (Van Miert 2002, Raetz 1993) . Endotoxaemia and Gram- negative septicaemia are important clinical entities in animals (Brigham and Meyrick 1986 , Ziegler *et al* 1991) Indeed, introduction of endotoxin into the circulation appears to be a key factor initiating the pathophysiology associated with clinical shock during experimental endotoxaemia (Morrison and Ryan 1987 , Naess *et al* 1989) . There are marked species differences both in the sensitivity of animals to endotoxin and the dose of endotoxin required to achieve 100% lethality (Berczi *et al* 1966 , Schrawen and Houvenaghel 1985). Van Miert and Frans (1968). Using endotoxin E. Coli lipopolysaccharide (LPS) found the following order of diminishing sensitivity: rabbit, horse, goat, dog, cow, sheep, cat, swine and chicken.

3. MATERIALS AND METHODS

Experimental design

Ten mature (3-5 years old, 200-250 kg body weight) camels (*Camelus dromedarius*) and 10 calves (2-3 weeks old, 30-34 kg body weight) of mixed sex were used in this study. Animals were divided randomly into four equal groups and kept individually in separate pens under natural day light and temperature. Groups A (5 calves) and B (5 adults) were injected intravenously (I.V) with 0.9% sterile sodium chloride and kept as controls. Groups C (5 calves) and D (5 adults) were injected I.V. with endotoxin. All animals were allowed free access to hay and water. Calves were left to suck freely between measurements. An indwelling catheter (Tygon microbore tubing 1.20 mm i.d., 1.78 mm o.d., Norton Performance Plastic, Ohio, USA) was inserted in a jugular vein one day prior to experiment for endotoxin injection and blood sampling. Blood samples (10 ml) were collected into heparinized tubes every 90 min. for the first 9 hours and every 2 hours thereafter until 15 hours postinjection. Plasma was separated by centrifugation at 1000g and stored at -20°C until analysis. Rectal temperature was measured at 15 min. intervals once at preinjection and during 8 hours of the trial period using telethermometer probe inserted 12 cm into the rectum (Yellow Springs Instrument Co. Ohio, USA).

Endotoxaemia

LPS prepared from E.coli serotype 055:B5; batch number 4005 (Sigma Chemicals Co. Ltd., Dorset, UK) was dissolved in normal saline at concentration of 2.5 µg/ml solution and filtered through a 0.2 µm Nalgene filter prior to use. The LPS was administered I.V. at a dose of 0.1 µg/kg body weight. This dose level was selected because in a pilot experiment a dose of 10 µg/kg body weight produced acute severe illness followed by death of 3 calves out of 3 and one adult out of 3 at 20 hour postinjection.

Analysis of Samples

Haematocrit (PCV) was determined using a microhaematocrit centrifuge (S 201 M, Sigma, England). Plasma concentration of thyroxine (T4), triiodothyronine (T3) and cortisol were determined with commercial solid phase RIA kits (Coat – A – Count, Diagnostic Product, Los Angeles, USA). The intra – assay and interassay coefficient of variation were 6.6. and 7.2%, respectively for T4; 8.2 and 11.6%, respectively for T3 and 8 and 9.6%, respectively for cortisol. Plasma aspartate aminotransferase (AST), Lactic dehydrogenase (LDH), creatinekinase (CK), protein and creatinine values were determined by VETTEST 8008 biochemical analysis (Sanofi Animal Health Ltd., UK). Glucose levels were determined using a compact glucose meter (Hypocount GA, Hypoguard Ltd, UK).

The data (mean values ± SD) were examined for statistical differences by analysis of variance and least significance difference tests. (Winer 1971)

4. RESULTS

The rectal temperature of animals in groups C and D (endotoxin treated) increased within 30 minutes following endotoxin administration (Fig. 1) and remained significantly ($P < 0.05$) elevated from 1 to 7 h postinjection in Group C and from 2 to 6 h postinjection in Group D compared to animals in groups A and B ($38.5 \pm 0.2^\circ\text{C}$). Maximum rectal temperature was 2.7 and 2.4°C above the preinjection rectal temperature ($38.6 \pm 0.2^\circ\text{C}$) at 3 and 4 h postinjection in calves and adult camels, respectively ($P < 0.05$).

Animals in group C and D appeared lethargic anorexic with excessive salivation during the course of fever. Calves showed marked depression and loss of suck reflex. Animals in group A and B appeared normal.

Haematocrit values increased significantly ($P < 0.05$) at 3 h postinjection and remained elevated until 9 h postinjection (Table 1). The effects of administration of endotoxin on various biochemical parameters are presented in Table 1. Total protein and urea levels were significantly ($P < 0.05$) decreased in groups C and D between 6 and 15 h for protein and between 5 and 9h postinjection for urea. Increase in glucose levels followed by decrease was also observed in these animals between 3 and 11 h post injection. Significant ($P < 0.05$) increase in AST and CK but not LDH activity was observed in animals of group C and D compared to those of group A and B.

Significantly ($P < 0.05$) higher activity of AST and CK was observed in group C compared to group D.

Administration of endotoxin to groups C and D significantly ($P < 0.05$) increased T3 and cortisol levels but not T4. The increase in T3 was short-lived; for only 4 h postinjection. The significant increase in cortisol concentration seen after endotoxin injection was sustained throughout the 15-h period after treatment. Significantly ($P < 0.05$) higher values for cortisol were seen in group C compared to group D. Values for creatinine, CK and AST were significantly ($P < 0.05$) higher in untreated calves than those in untreated adults (Table 2). After *E. coli* LPS administration increases in cortisol values were significantly ($P < 0.05$) higher in calves than those in adults: (Table 2).

5. DISCUSSION

Administration of endotoxin resulted in an increase in rectal temperature. Similar effects of endotoxin administration in calves (Morris *et al* 1986), goat, sheep, cow, rabbit (van Miert 1985), horse (Burrows 1981), cat (Justus and Quirke 1995) and piglet (Desaedeleer *et al* 1992, Carroll *et al* 2001) were observed. The higher and earlier rise of temperature in endotoxin treated calves compared to adult may be due to differences in the rate of heat conservation and heat loss between young and adult (Van Miert and Atmakusuma 1971). Body fluid distribution changes are commonly associated with endotoxaemia (van Miert *et al*, 1983). The increase in haematocrit values during febrile period suggesting that only at this time there was a significant shift in body fluid distribution (Southorn and Thompson 1986). Fever is mediated by endogenous substances such as interleukin -1, interleukin -6, INF - α or endogenous pyrogens (Van Miert 2002) which stimulate the thermoregulatory centres in the hypothalamus (Lohuis *et al*, 1988). Thyroid hormones and cortisol modulate metabolic processes (Ganong 1989). The increase in these metabolic hormones induced by endotoxin will explain their involvement in thermoregulation, because metabolism is a primary, intrinsic source of heat (Finch 1986). Additionally, cortisol is an important indicator of stress in ruminants (Browning *et al*, 1998) and plays a role in a negative feedback mechanism to maintain homeostasis (Van Miert 2002). It is well known that young animals are more sensitive to endotoxins than adults. This probably explains why cortisol values in calves were significantly higher than those in adult (Table 2). The transient increase in glucose concentration at 3h postinjection may represent a direct effect of cortisol and T3 as both hormones exert a hyperglycemic effect (Southorn and Thompson 1986). In addition, the increase in glucose is at least partly due to release of catecholamines as these are released during endotoxin-induced fever (Van Miert 1973). The subsequent decrease in glucose concentration was due to progressive depletion of glycogen stores in the liver associated with fever (Wolfe 1981). Endotoxaemia usually produce hypovolemia due to increased capillary permeability (Olson *et al* 1995). Hypovolemia, in turn could be a reason for an apparent decrease in plasma protein, urea, glucose and creatine levels, as these metabolites maybe lost with plasma into the extra vascular space (Olson *et al* 1995)

Furthermore, the low plasma protein and urea levels in endotoxin-treated camels could have resulted from reduced liver synthesis or decreased intestinal absorption. Similar effects have been reported in sheep, rabbits, pigs and rats as endotoxin

induced a reduction in gastric emptying rate and secretion (Leenen and Van Miert 1969; Van Miert and de La Parra 1970; Duranton and Buerno 1984, Desaedeleer *et al* 1992).

The increase in AST and CK activity suggests that endotoxin induced hepatic and skeletal muscle damage . Similar effects on serum enzymes have been produced in cows (Verheijden and Burvenich 1985) and goats (Van Miert *et al* 1983). The higher activity of these enzymes in untreated calves compared to adult untreated camels may be attributed to less stable biological membranes in calves which allow more leakage of cellular enzymes into the plasma (Sarwar *et al* 1992).

Various dose levels were used in the literature to produce endotoxaemia in animals (Van Miert and Frens 1968). These have included a dose of 0.5 µg/kg in calves (Morris *et al* 1986), 0.1 µg/kg in goat and rabbit (Van Miert 1985) and 10 µg/kg in piglet (Desaedeleer 1992) and ponies (Moore *et al* 1981).

Considering the size of the dose (0.1 µg/kg) of endotoxin administered to camels the findings of the present study demonstrate a high sensitive response of both calves and adult camels to endotoxaemia as the case in rabbit and goat (Van Miert 1985) .

6. REFERENCES

- Berczi, I., Bertok, L. and Bereznai, T. 1966: Comparative studies on the toxicity of lipopolysaccharide endotoxin in various animal species. *Canadian Journal of Microbiology* 12, 1070-71.
- Brigham, K. L. & Meyrick, B. 1986: State of Art. Endotoxin and lung injury. *American Review of Respiratory Disease* 133, 913-27.
- Browning, JR., Leite-Browning M.L., Smith H.M. and Wakefield, T., 1998 : Effect of ergotamine and ergonovine on plasma concentrations of thyroid hormones and cortisol in cattle. *Journal of Animal Science* 76, 1644-1650.
- Burrows G.E. 1981 : Endotoxaemia in the horse. *Equine Veterinary Journal*, 13, 89-94.
- Carroll J.A. Matteri R.L., Dyer C.J. Beausang L.A. and Zannelli M.E. 2001. Impact of environmental temperature on response of neonatal pigs to an endotoxin challenge. *American Journal of Veterinary Research*, 62, 561-566.
- Desaedeleer, V. Wechsung, E. and Houvenaghel A. 1992 : Influence of endomethacin on endotoxin – induced changes in gastrointestinal myoelectrical activity and some hematological and clinical parameters in the conscious piglet. *Veterinary Research Communications*, 16, 59-67 .

- Durantón, A. and Bueno, L., 1984: Central opiate mechanism involved in gastrointestinal motor disturbance induced by *E. coli* endotoxin in sheep. *Life Sciences* . 34, 1759-1799.
- Finch, V.A. 1986. Body temperature in beef cattle: Its control and relevance to production in the tropics. *Journal of Animal Science*, 62: 531-542.
- Ganong, W.F. 1989. Review of Medical Physiology (14th Ed). Appleton & Lange, Norwalk, CT.
- Justus C. and Quirke J.F. 1995. Dose-response relationship for the antipyretic effect of meloxicam in endotoxin model in cats. *Veterinary Research Communications* 19, 321-330.
- Leenen , F.H.H. and Van Miert , A.S.J.P.A.M. 1969 . Inhibition of gastric secretion by bacterial lipopolysacchariae in the rat . European Journal of *Pharmacology* , 8 , 228-231 .
- Lohuis, J.C.C.M. Verheijden, J.H.M., Burvenich, C. and Van Miert, A.S.J.P.A.M., 1988: Pathophysiological effects of endotoxins in ruminants. 1. Changes in rectal temperature and reticulo-rumen motility , and the effect of repeated administration. *The Veterinary Quarterly*, 10, 109-125.
- Morrison, D.C. and Ryan, J.L., 1987. Endotoxins and disease mechanisms . In Annual Review of Medicine 38. eds W. P. Creger . C.H. Coggins & E. W. Hancock, pp. 417-32. *Palo Alt. Annual Reviews* .
- Moore J.N., Garner H.E., Shapland J.E. and Hatfield D.G. 1981. Prevention of endotoxin-induced arterial hypoxaemia and lactic acidosis with flunixin meglumine in the conscious pony. *Equine Veterinary Journal* 13, 95-98.
- Morris D.D., Bottoms G.D. Whitlock R.H. and Johnson M.A. 1986. Endotoxin-induced changes in plasma concentration of thromboxane and prostacylin in neonatal calves given antiserum to a mutant *Escherichia coli* (J-5). *American Journal of Veterinary Research* 47, 2520-2524.
- Naess, F., Roeist, O., Pulgram-Larsen, J., Ruud, T.E., Stadaas, J.O. and Aases, A.O. 1989. Plasma proteolysis and circulating cells in relation to varying endotoxin concentrations in porcine endotoxaemia. *Circulatory shock* 28 , 89-100.
- Olson N.C., Hellyer P.W. and Dodam J.R. 1995 : Mediators and vascular effects in response to endotoxin . *British Veterinary Journal* 151, 489-521.
- Raftz, C.R.H. 1993 . Bacterial endotoxins : Extraordinary lipids that activate eucaryotic signal transduction. *Journal of Bacteriology* 175, 5745-53.
- Sarwar A., Majeed M.A., Hur G. and Khan I.R. 1992. Studies on the serum transferases and electrolytes of normal one humped camel in Summer. *Pakistan Veterinary Journal* 12, 175-182.

- Schrauwen, E. and Houvenaghel., A. 1985: Hemodynamic evaluation of endotoxic shock anesthetized piglets : antagonism of endogenous vasoactive substances. *Circulatory shock* 16, 19-28 .
- Southorn B.G. and Thompson J.R. 1986 : Time course changes in blood metabolites during endotoxin fever in sheep. *Canadian Journal of Veterinary Research* 50, 374-379.
- Van Miert A.S.J.P.A.M., Van Duin C.T.M., Verheijden J.H.M., Schotman A.J.H. 1983: Staphylococcal enterotoxin B and Escherichia Coli endotoxin . Comparative observations in goats on fever and associated clinical hematological and blood biochemical changes after intravenous and intramammary administration. *American Journal of Veterinary Research* 44, 95-963.
- Van Miert , A.S.J.P.A.M. and de la Parra , D.A. 1970 . Inhibition of gastric emptying by endotoxin (bacterial lipopolysaccharide) in conscious rats and modification of this response by drugs affecting the autonomic nervous system. *Archives Internationals de Pharmacodynamie et de Therapie* , 184, 27-33 .
- Van Miert , A.S.J.P.A.M. and Atmakusuma , A. 1971 . Fever induced with leucocytic or bacterial pyrogen in young and adult goats . *Journal of comparative pathology* 81 , 119-137
- Van Miert , A.S.J.P.A.M. 2002 . Present concepts on the inflammatory modulators with special reference to cytokines . *Veterinary Research Communications* 26, 111-126 .
- Van Miert A.S.J.P.A.M. 1973. Clinical symptoms induced by E.coli endotoxin in goats. *Zentralblatt für Veterinärmedizin* A20, 614-623.
- Van Miert A.S.J.P.A.M. 1985: Fever and associated clinical haematologic and blood biochemical changes in the goat and other animals species. *The Veterinary Quarterly* 7, 200-216.
- Van Miert A.S.J.P.A.M. 2002. Present concepts on the inflammatory modulators with special reference to cytokines. *Veterinary Research Communications* 26, 111-126.
- Van Miert A.S.J.P.A.M. and Frens J. 1968. The reaction of different animal species to bacterial pyrogens. *Zentralblatt für Veterinärmedizin* A 15, 532-543.
- Verheijden , J. H. M. and Burvenich , CL 1985 Pathophysiological effects of bacterial endotoxins in ruminants. A review., *Veterinary Research Communications* 9, 402-410.
- Winer B.J. 1971. Statistical principles in experimental design. 2nd ed. New York. McGraw-Hill Book Co.

Wolfe, R. R. 1981: Glucose metabolism in sepsis and endotoxemia . In: POWENDA, M. C. and CANONICO, P.G. Infection. The physiological and metabolic responses of the host. Elsevier North Holland Biomed. Press, *Amsterdam-New York Oxford* 213-44.

Ziegler, F., J. Fisher, C.J. Spring, C. I. 1991: Treatment of gram-negative bacteremia and septic shock with HA-IA human monoclonal antibody against endotoxin. A randomized , double-blind , placebo-controlled trial. *New England Journal of Medicine* 324, 129-36.

Table 1. Mean \pm SD of plasma concentration of biochemical parameters in experimentally induced endotoxaemia in camels.

		Time (hours) after i.v. injection of 0.1 μ g per kg b.w. E.coli LPS (Groups C and D; 5 animals each)																					
Parameter	Controls (Groups A & B; 5 animals each)		0		1.5		3		4.5		6		7.5		9		11		13		15		
	A	B	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	
Haematocrit (%)	0.23 (0.01)	0.27 (0.01)	0.24 (0.4)	0.26	0.28* (0.01)	0.31 (0.02)	0.32* (0.02)	0.33* (0.02)	0.33* (0.02)	0.34* (0.02)	0.32* (0.02)	0.33* (0.02)	0.31* (0.02)	0.32* (0.02)	0.33* (0.02)	0.32* (0.01)	0.28* (0.02)	0.27 (0.01)	0.26* (0.01)	0.27 (0.01)	0.25* (0.01)	0.26 (0.01)	
Total protein (g/dl)	4.9 0.2	5.2 (0.4)	5.1 (0.2)	5.5 (0.4)	4.4 (0.2)	5.1 (0.3)	4.2 (0.3)	4.5 (0.3)	3.7* (0.2)	4.1 (0.3)	3.4* (0.2)	3.9* (0.3)	3.3* (0.3)	3.8* (0.3)	3.2* (0.2)	3.4* (0.3)	3.1* (0.2)	3.6* (0.2)	3.1* (0.3)	3.4* (0.2)	3.1* (0.2)	3.5* (0.2)	
Urea nitrogen (mg/dL)	11.1 (1.2)	12.0 (1.3)	11.2 (1.3)	11.6 (1.2)	11.6 (1.2)	12.1 (1.3)	10.6 (1.3)	11.2 (1.2)	7.6 (1.4)	8.3* (0.8)	7.1* (1.1)	7.2* (0.6)	7.1* (0.7)	7.5* (0.6)	7.6* (0.6)	8.4* (0.9)	8.1* (0.9)	10.2 (1.2)	9.2* (1.1)	11.7 (1.2)	10.1* (1.2)	11.4 (1.3)	
Glucose (mg/dL)	105 (12)	121.1 (16)	110 (12)	116 (15)	117 (11)	122 (15)	133* (14)	141* (18)	146* (16)	111 (16)	86* (9)	93* (12)	80* (9)	85* (11)	82* (9)	80* (10)	84* (10)	86* (10)	90* (10)	105 (10)	89* (11)	111 (11)	
Creatinine (mg/dL)	1.11 (0.02)	0.86 (0.02)	1.12 (0.02)	0.84 (0.03)	1.2 (0.02)	0.88 (0.03)	1.3* (0.03)	1.11* (0.06)	1.4* (0.03)	1.22* (0.06)	1.33* (0.03)	1.30* (0.08)	1.4* (0.03)	1.31* (0.08)	1.41* (0.03)	1.15* (0.08)	1.42* (0.03)	0.95* (0.06)	1.3* (0.02)	0.88 (0.04)	1.3* (0.02)	0.88 (0.03)	
Creatine kinase (IU/L)	110 (5)	68.1 (3.1)	112 (6)	66.2 (3)	120 (5)	69.1 (3.1)	130 (6)	90.1* (4.1)	135* (8)	102* (41)	140* (7)	95.6* (4.1)	140* (7)	94.1* (4.2)	140* (6)	93.2* (4.2)	130* (6)	71.1 (3.1)	130* (7)	68.1 (3.2)	140* (7)	67 (3.1)	
Aspartate aminotransferase (IU)	190 (8)	55 (4)	193 (11)	59 (4.1)	200 (11)	61 (4.2)	211* (12)	78.3* (4.1)	220* (12)	80.1* (4.2)	230* (10)	82.3* (4.3)	230* (12)	86.7* (4.4)	236* (2)	85.2* (4.4)	234* (11)	65.1* (4.2)	231* (10)	60 (3.9)	220* (9)	61 (3.1)	
Lactic dehydrogenase (IU)	160 (13)	140 (12)	162 (14)	146 (12)	150 (14)	136 (11)	166 (14)	142 (11)	162 (14)	133 (12)	155 (13)	135 (11)	156 (13)	139 (12)	158 (15)	146 (12)	161 (14)	150 (12)	162 (14)	142	158 (14)	144 (12)	

* Indicate statistically significant differences (P < 0.05).

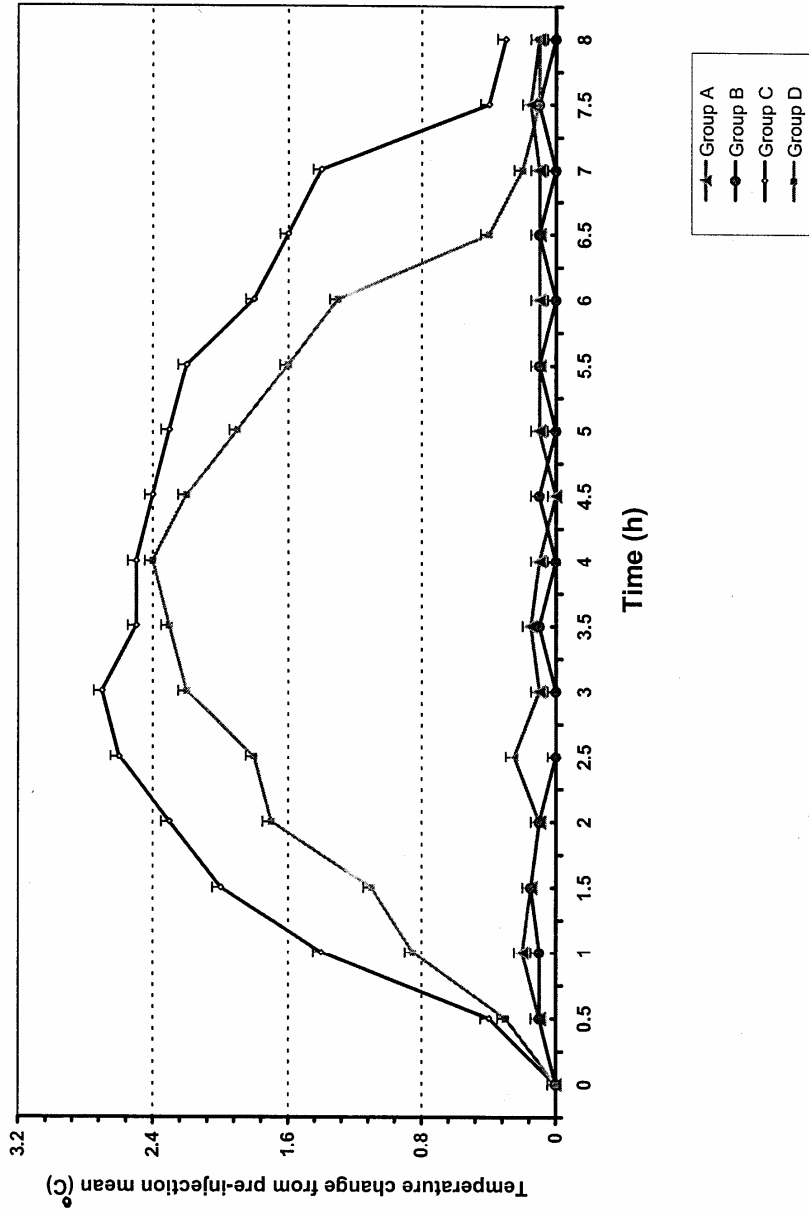
Table 2. Mean \pm SD of Plasma T3, T4 and cortisol after i.v. injection of 0.1 μ g per kg b.w. in camels (groups C and D; 5 animals each)

Time (h)	Thyroxine				Triiodothyronine				Cortisol			
	A	B	C	D	A	B	C	D	A	B	C	D
0	71.1 (1.9)	72.2 (1.3)	73.2 (2.0)	74.1 (2.1)	1.15 (0.02)	1.13 (0.02)	1.11 (0.02)	1.10 (0.03)	13.4 (1.8)	14.3 (1.6)	15.1 (2.1)	14.6 (2.3)
1.5	72.1 (1.3)	71.1 (1.6)	75.1 (2.1)	74.2 (2.2)	1.10 (0.02)	1.10 (0.02)	1.6* (0.04)	1.4* (0.3)	14.6 (1.6)	13.6 (1.8)	70* (6.1)	50.1* (3.6)
3	71.6 (1.4)	72.6 (1.4)	75.2 (2.3)	76.3 (2.3)	1.12 (0.02)	1.11 (0.02)	1.65* (0.04)	1.35* (0.02)	13.6 (1.6)	13.1 (1.5)	82* (4.6)	70.21* (5.2)
4.5	71.8 (1.5)	72.5 (1.5)	79.4 (2.1)	77.1 (2.4)	1.14 (0.02)	1.12 (0.02)	1.56* (0.04)	1.32* (0.02)	12.6 (1.4)	14.1 (1.6)	86* (4.5)	72.4* (5.1)
6	72.2 (2.0)	73.1 (1.4)	76.3 (2.4)	75.3 (2.1)	1.16 (0.02)	1.10 (0.02)	1.45* (0.04)	1.1 (0.02)	14.2 (2.1)	13.4 (2.6)	80.1* (5.1)	67.2* (5.4)
7.5	71.5 (1.6)	72.1 (1.6)	78.2 (2.3)	76.2 (1.9)	1.12 (0.02)	1.13 (0.02)	1.15 (0.03)	1.12 (0.03)	14.1 (1.3)	13.9 (1.6)	82.3* (5.1)	62.6* (5.1)
9	72.1 (1.6)	71.9 (1.6)	73.3 (2.1)	74.1 (2.1)	1.13 (0.02)	1.14 (0.02)	1.11 (0.02)	1.12 (0.03)	13.9 (1.6)	14.2 (2.1)	79.1* (4.3)	62.6* (5.1)
11	71.4 (1.4)	71.8 (1.7)	72.1 (2.2)	75.1 (2.0)	1.12 (0.02)	1.13 (0.03)	1.12 (0.03)	1.13 (0.03)	14.2 (1.3)	14.2 (2.1)	78.2* (4.3)	54.4* (5.2)
13	71.4 (1.8)	73.1 (2.3)	73.2 (2.2)	74.4 (1.9)	1.11 (0.01)	1.12 (0.02)	1.11 (0.02)	1.1 (0.02)	12.6 (1.9)	13.6 (2.1)	79.1* (5.1)	56.6* (5.2)
15	72.1 (1.5)	70.9 (1.6)	74.1 (2.1)	75.6 (1.9)	1.10 (0.02)	1.11 (0.03)	1.12 (0.02)	1.1 (0.02)	13.1 (1.4)	13.6 (1.9)	76.2* (5.2)	53.4* (5.1)

- Indicate statistically significant difference ($P < 0.05$).

Legend for figure 1.

Change in rectal temperature in control (Group A and B) and after i.v. injection of 0.1 μg per kg b.w. *E. coli* LPS (Group C and D) camels (n = 10).



2.11.2003

Prof. Dr. A.S.J.P.A.M. Van Miert
Utrecht University
Faculty of Veterinary Medicine
Dept. of Veterinary Pharmacology,
Pharmacy and Toxicology
P.O. Box 80.152
3508 TD UTRECHT,
The Netherlands

Ref. VRC 3025

Dear Prof. Van Miert

Thank you so much for your letter of October , 9 : “ Some endotoxin – induced clinical and biochemical changes in plasma of camels” . I have considered all your valuable comments, suggestions and corrections . A corrected version is now enclosed for your kind consideration .

Yours sincerely,

Dr. Abdulla, M. AL-Dughaym

Dept. of Microbiology and Parasitology
College of Veterinary Medicine and
Animal Resources
King Faisal University
P.O. Box. 1757 Al-Ahsa 31982
Saudi Arabia
E-mail : AMD1995@hotmail.com

