

Preliminary Report**BLOOD VALUES AND SKULL DIMENSIONS IN ANESTHETIZED
CYNOMOLGUS MONKEYS** (*Macaca fascicularis*)

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ABSTRACT

Hematological determinants, including clinical chemistry values and skin dimensions were presented for 1 to 2 year-old male and female *Macaca fascicularis* of Peninsular Malaysian strain. No significant differences were found between sexes. The results showed a considerable variation in blood values in these animals a similar trend shown by previously reported values for the adult cynomolgi.

Introduction

Non human primates remain one of our most valuable resource to study human disease. The rhesus (*Macaca mulatta*) has probably been used most extensively, and considerable baseline data, including normal hemotologic determinants for this species have been documented. (Gardner, 1954 ; Krise & Wald, 1958 ; Anderson ; 1966 ; King & Gargus, 1967 ; Petery, 1967 ; Robinson & Ziegler, 1968 ; Turbyfill, *et al.* 1970 ; Altschuler, *et al.*, 1971 ; Vogin & Oser, 1971 ; Martin, *et al.*, 1973 ; Loomis, *et al.*, 1980 ; Porter, 1982). Cynomolgus (*Macaca fascicularis*) are much easier to acquire and breed in captivity in Thailand than the rhesus. For this reason, our group has extensively utilized the cynomolgus in some research. For various reasons, it is sometimes necessary or more practical to use juvenile monkeys. Although normal blood values for adult cynomolgus have been reported previously (Vogin & Oser, 1971 ; Altschuler, *et al.*, Verlangieri, *et al.*, 1985), to our knowledge, hematological parameters including clinical chemistry values or skull dimensions have not been reported in 1 to 2 year-old cynomolgus. Skull dimensions for this species have been useful in certain studies where it is initial to relate external anatomical parameter of the calvarium to specific brain regions (Angsubhakorn, *et al.*, 1986). This report gives data from eighteen anesthetized *M. fascicularis*, of Peninsular Malaysian strain raised by the Department of Veterinary Medicine, Armed Forces Research Institute of Medical Sciences (AFRIMS), Bangkok, Thailand.

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Materials and Method

Experimental Animals

The 18, male and female, 1-2 year-old cynomolgus monkeys were born in the colony at Department of Veterinary Medicine, AFRIMS. Their parents originated in Peninsular Malaysia. All monkeys were housed in groups of 12-22 in large gang cages in an indoor facility. All animals were fed a standard ration (Wayne Laboratory Animal Diets, Chicago, Ill.) given fresh fruit 2 times weekly, and water *ad libitum* was provided. During this study, each animal was maintained in individual cage measuring $70 \times 62 \times 70$ cm³. The subjects were fasted 17 hr. prior to sampling, and all samples were taken in the morning hours.

Blood Collection

Each monkey was sedated with 10 mg./kg. Ketamine hydrochloride (ketaset, Bristol Laboratories, Syracuse, New York 13201), intramuscularly. Using 20 ml disposable syringe, approximately 20 ml. of blood was drawn from the femoral venous plexus of the monkey. Three ml. of blood were quickly transferred to a glass tube containing 60 μ l of EDTA. The remaining blood was allowed to clot for serum analysis.

Sample Analysis

All enzyme values were determined by method listed in Table 1 using an automated clinical analyzer, Technicon SMA II (Technicon Instruments Corporation, Tarrytown, New York 19591). All serum assays were compared to internal and external standard while both normal and abnormal controls were included with each analytical run. Values falling in the abnormal range were verified by repeated analysis.

Hematological values were determined in order of priority using Hemalog D and Hemalog 8 (Technicon Instruments Corporation, Tarrytown, New York 19591).

Growth

Body weights and skull dimensions were done at the time of blood sampling. Body weights were determined using as conventional scale. Skull length was measured from external occipital protuberance to the frontonasal suture; the skull width was measured between external auditory (acoustic meatuses). The measurements were performed by using a vernia caliper (Mitutoyo, Japan).

Data Analysis

All values were analyzed by the student's t-test. The criterion for significance was set a $P < 0.05$.

Results and Discussion

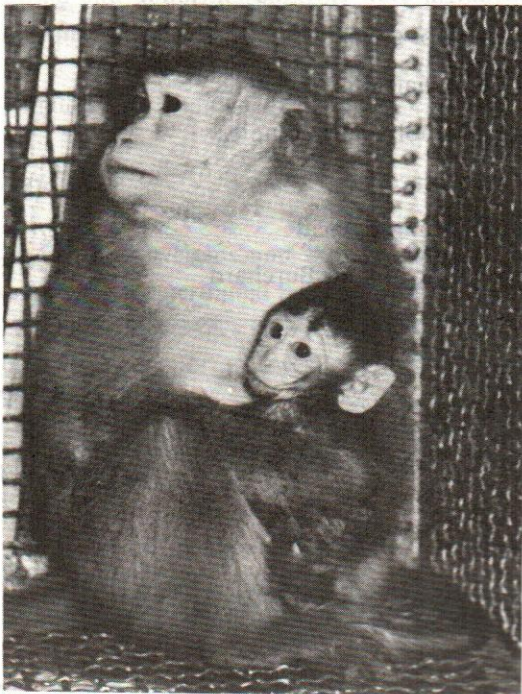
Mean body weights and skull dimensions in male and female monkeys are given in Table 2. No significant differences were found between mean body weights or width and length of the skull in either sexes. There were no significant differences in any blood parameters (Table 3) between sexes, except females showed higher percentage of eosinophils than males (Table 3). Our results from this present study in cynomolgus monkeys are in good agreement with those obtained the previous investigation (Verlangieri, *et al.*, 1985) and there was a large standard deviation in several values in blood chemistry and hematology. Comparable values reported in the adult male (Verlangieri, *et al.*, 1985) and our 1 to 2 year-old male cynomolgus monkeys under the same anesthetized condition are shown in Table 4. In the previous study (Verlangieri, *et al.*, 1985), the male adults had a lower level of cholesterol and mean corpuscular volume (MCV) compared to the juveniles in our study. Conversely, levels of calcium, red blood cell count, and eosinophils were higher in the previous study. There was no significant differences in any other blood parameter.

Table 1. Analytical methods employed to determine blood values in juvenile cynomolgus monkeys.

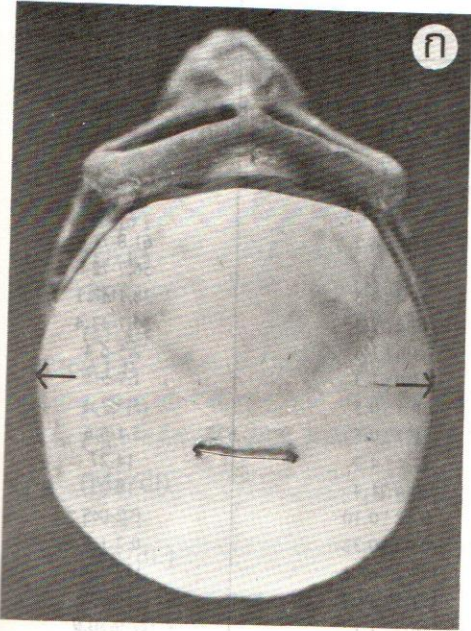
Test	Method
Alkaline Phosphatase (AP)	P-nitrophenyl phosphate
Lactate Dehydrogenase (LDH)	UV kinetic
Serum Glutamic Oxaloacetic-transaminase (SGOT)	MDH/LADH
Total Protein (TP.)	Biuret
Albumin (ALB)	Bromocresol green
Calcium (Ca ⁺⁺)	Cresolphthalein complexone
Inorganic Phosphate (IN.P.)	Phosphomolybdate complex
Blood urea Nitrogen (BUN)	Urease/Diacetylc
Uric acid (UA)	Phosphotungstic acid
Cholesterol enzyme (CHOL. ENZ.)	Direct Liebermann Burchard

Table 2. Body and brain weights, skull and brain dimensions in Anesthetized juvenile cynomolgus monkeys (*Macaca fascicularis*)

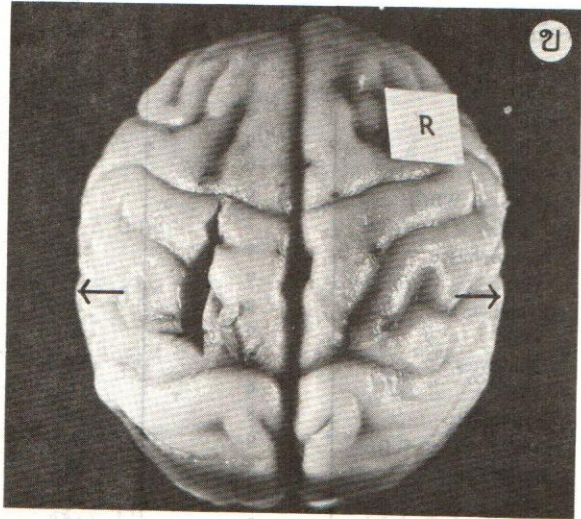
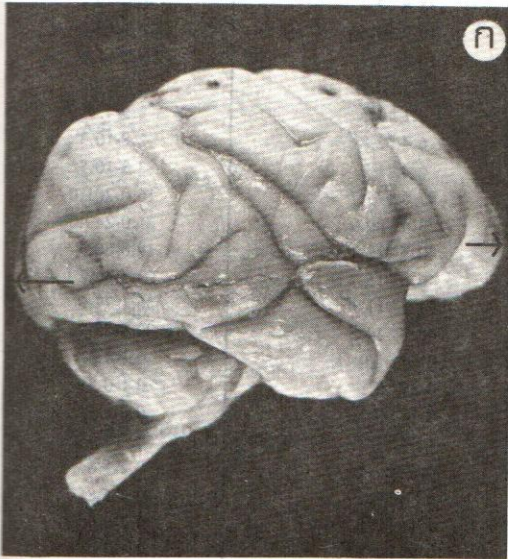
Determination	No. of monkey	Sex	Mean \pm 1 S.D.	Observed range
Body weight (g.)	9	M	1,644 \pm 181	1,400 - 2,000
	9	F	1,633 \pm 291	1,300 - 2,200
Brain weight (g.)	9	M	61.2 \pm 4.3	54.2 - 68.5
	9	F	58.4 \pm 4.7	52.1 - 65.0
Brain length (mm.)	9	M	63.7 \pm 2.5	60.0 - 68.0
	9	F	61.6 \pm 1.9	59.0 - 65.0
Brain width (mm.)	9	M	52.3 \pm 1.5	50.0 - 55.0
	9	F	50.8 \pm 1.8	49.0 - 55.0
Skull length (mm.)	9	M	73.1 \pm 2.6	70.0 - 78.0
	9	F	72.2 \pm 2.1	70.0 - 76.0
Skull width (mm.)	9	M	60.5 \pm 1.0	59.0 - 62.0
	9	F	60.2 \pm 2.5	58.0 - 65.0



รูปที่ 1. ลูกลิงแสมตัวแรกที่เกิดใน
ห้องปฏิบัติการวิจัยพิษวิทยาวิทยา
ในวันที่ 2 มกราคม 2530



รูปที่ 2. ภาพกะโหลกศีรษะ (ก) ด้านบน และ (ข) ด้านข้าง พร้อมทั้งจุดที่ใช้วัดขนาด



รูปที่ 3. ภาพสมอง (ก) ด้านข้าง และ (ข) ด้านบน พร้อมทั้งจุดที่ใช้วัดขนาด

Table 3. Blood values found in anesthetized juvenile cynomolgus monkeys (*Macaca fascicularis*)

Determination	No. of monkey	Sex	Mean \pm 1 S.D.	Observed range
AP	6	M	> 350	-
(U/L)	6	F	145.3 \pm 138.3	11-309
LDH	8	M	> 600	-
(U/L)	7	F	> 600	-
SGOT	9	M	59.1 \pm 17.7	24-85
(U/L)	9	F	45.0 \pm 17.6	21-69
TP	9	M	67.8 \pm 4.2	61.8-74
(G/L)	9	F	66.1 \pm 5.1	56.7-72.6
ALB	9	M	41.4 \pm 3.3	38.1-48.1
(G/L)	9	F	40.3 \pm 2.5	35.7-43.4
Ca ⁺⁺	9	M	4.6 \pm 1.3	2.5-6.4
(mg./dl.)	8	F	3.9 \pm 1.3	1.7-5.5
IN.P.	9	M	6.1 \pm 0.5	5.5-7.4
(mg./dl.)	9	F	5.7 \pm 0.5	5.1-6.6
BUN	9	M	21.6 \pm 4.7	14-27
(mg./dl.)	8	F	20.6 \pm 1.4	19-23
UA	9	M	0.32 \pm 0.10	0.2-0.5
(mg./dl.)	9	F	0.42 \pm 0.32	0.2-1.6
CHOL.ENZ.	5	M	199.2 \pm 42.4	157-266
(mg./dl.)	6	F	191.5 \pm 39.7	116-230
MCHC	9	M	28.5 \pm 1.1	27.0-30.9
(%)	9	F	28.9 \pm 0.8	27.7-30.6
MCH	9	M	24.9 \pm 1.0	23.1-26.1
(pg.)	9	F	25.0 \pm 1.7	22.6-27.6
MCV	9	M	87.6 \pm 4.2	79.0-92.0
(%)	9	F	86.6 \pm 4.9	79.0-94.0
PCV	9	M	38.3 \pm 3.3	33.1-44.4
(%)	9	F	35.8 \pm 2.7	30.9-39.1
HB	9	M	10.9 \pm 0.6	10.1-12.0
(g./dl.)	9	F	10.4 \pm 0.7	9.0-11.4
RBC	9	M	4.3 \pm 0.3	3.9-5.0
($\times 10^6$)	9	F	4.1 \pm 0.5	3.5-4.8
WBC	9	M	6.4 \pm 2.8	2.8-10.3
($\times 10^3$)	9	F	6.8 \pm 1.9	3.3-10.5
PLTS. (+ WBC)	8	M	82.5 \pm 75.7	16.0-201.0
($\times 10^3$)	7	F	123.4 \pm 89.9	21.0-249.0
Neutrophils	9	M	40.7 \pm 12.1	19.0-60.4
(%)	9	F	46.8 \pm 15.7	23.4-66.2
Lymphocytes	9	M	54.5 \pm 11.8	36.1-77.0
(%)	9	F	48.0 \pm 14.8	29.9-68.2
Monocytes	8	M	0.53 \pm 1.0	0.1-3.0
(%)	6	f	0.25 \pm 0.1	0.1-0.5
Eosinophils	8	M	0.76 \pm 0.2	0.2-1.1
(%)	9	F	1.33 \pm 1.2	0.1-3.4
Basophils	8	M	0.47 \pm 0.4	0.2-1.6
(%)	9	F	0.60 \pm 0.6	0.2-1.8
Large unstained cells (%)	8	M	0.41 \pm 0.2	0.2-0.9
Remainder	8	M	2.8 \pm 0.8	1.8-4.7
(%)	9	F	2.3 \pm 0.4	1.8-2.7
Total WBC	8	M	13.2 \pm 6.9	5.4-20.7
(cells $\times 10^3$ /mm. ³)	9	F	11.2 \pm 4.6	3.3-17.6

Acknowledgement

Table 4. Blood values found in anesthetized adult and juvenile male cynomolgus monkeys (*Macaca fascicularis*)

Determination	Verlangieri, <i>et al.</i>	Present study.
	Anesthetized adult Mean ± S.D.	Anesthetized Juvenile Mean ± S.D.
SGOT (U/L)	38.4 ± 18.3	59.1 ± 17.7
TP (G/L)	76.0 ± 3.9	67.8 ± 4.2
ALB (G/L)	40.0 ± 2.1	41.4 ± 3.3
Ca ⁺⁺ (Mg/dl)	8.9 ± 0.39	4.64 ± 1.36
IN.P. (mg/dl.)	6.2 ± 2.09	6.1 ± 0.58
BUN (mg/dl.)	18 ± 2.8	21.6 ± 4.7
UA (mg/dl.)	0.14 ± 0.13	0.32 ± 0.10
CHOL. ENZ (mg/dl.)	127 ± 20.9	199.2 ± 42.4
MCHC (%)	33.3 ± 1.5	28.5 ± 1.1
MCH (pg.)	20.1 ± 1.3	24.9 ± 1.0
MCV (%)	62.2 ± 3.4	87.6 ± 4.2
HB (g/dl)	11.7 ± 0.68	10.9 ± 0.69
RBC (× 10 ⁶)	5.8 ± 0.47	4.3 ± 0.37
WBC (× 10 ³)	9.3 ± 3.2	6.4 ± 2.82
Neutrophils (%)	48 ± 13	40.7 ± 12.1
Lymphocytes (%)	45 ± 11	54.5 ± 11.8
Monocytes (%)	1.7 ± 1.3	0.53 ± 1.0
Eosinophils (%)	5.2 ± 3.9	0.76 ± 0.28

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