Hematology and Serum Chemistry Values of Growing Miniature Pigs

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The purpose of this study was to establish blood reference values for miniature pigs from various growth ages before pre-puberty. 12 miniature pigs from two swine farms were sampled by jugular venipuncture. Routine hematological and biochemical determinations were performed using whole blood and serum. For the variables examined in each age group the means and the standard deviations were calculated. In hematological values, there are significant changes ($p < 0.05$) in RBC, hematocrit and platelet values in each group. In RBC and hematocrit values, 4-week group shows the lowest level, whereas in platelet values, 4-week group shows the highest level. In biochemical values, there are significant changes ($p < 0.05$) in glucose and GGT in each group, and in other biochemical values there are no significant changes during growing periods. The values presented here may be useful for knowing the normal values for miniature pigs and also screening the normal pigs in the early days of their life and during the developmental stages.

Key words : Miniature pigs, blood chemistry, hematology, reference values, developmental stages

Introduction

The alleged chronic shortage of human organ has led some researchers to consider using animals. Of all the species that have received consideration as potential sources of organs for xeno-transplantation into man, the pig remains the most likely candidate [10,14]. In the experiments, for the reason of the convenience, effectiveness, tamed characteristics, miniature pigs have been used rather than conventional pigs.

Though the reference values for hematology and serum biochemistry of conventional pigs are documented in the literature [1,2,9,12], few studies during growing period in miniature pigs have been conducted.

The aim of this paper is to establish blood and serum reference values for growing miniature pigs in order to obtain updated routine biochemical and hematological references intervals and values.

Materials and Methods

Animals

Experimental miniature pigs are raised in PWG Genetics farm and Animal Science farm of College of Agriculture and Bioscience, Seoul National University.

Using 12 miniature pigs (PWG; PWG Genetics, Korea), blood samples (5 ml) were taken by jugular venipuncture. We studied the normal hematological values during 4, 8, 12 and 20 week of age.

Hematological analysis

CBC of aspirated blood samples was done with a veterinary hematology counter (MS9-5V, Melet Schloensing Laboratoires, France). The serum biochemistry profile values were analyzed with a benchtop chemistry system (Analyst, Analytical test rotor, Hemagen Diagnostics, Inc. U.S.A.).

In addition to the hematological analysis, the body weight, waist and height were also measured.

To measure the body weight, a digital scale was used and to measure the waist circumference and height, a tape scale was used. Waist circumference was measured above pig's hip bone and height was measured from the tip of the hoof to the highest point (scapula cartilage) of the scapula.

Reference values (mean, SD) obtained were examined by age groups and the reference limits were calculated. Each value of age groups was analyzed with one-way ANOVA and multiple comparison using SPSS (SPSS-12K for Windows, SPSS Inc., U.S.A.), and $p < 0.05$ was considered as significant.

Results

In hematological values, there are significant changes

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($p<0.05$) in RBC, hematocrit and platelet values in each group, and in other values there are no significant changes during growing periods (Table 1). In RBC and hematocrit values, 4-week group shows the lowest level, whereas in platelet values, 4-week group shows the highest level.

In biochemical values, there are significant changes ($p<0.05$) in glucose and GGT in each group, and in other biochemical values there are no significant changes during growing periods (Table 2).

In GGT values, 8- and 12-week groups show higher level compared with the 4- and 20-week groups. In glucose val-

ues, 8-week group shows the lowest level compared with other groups. And in body weight, there are significant increase ($p<0.05$) as they grow (Table 3).

In body weight, waist circumference and weight, as pigs grow, their body weight and size were increased significantly ($p<0.05$).

Discussion

Blood and blood chemical values were studied in our experiment in miniature pigs during growing period. All these

Table 1. Normal hematological values in miniature pigs (Mean $\pm$ SD)

	Unit	4 weeks	8 weeks	12 weeks	20 weeks
WBC	$10^3/\mu\text{l}$	13.26 $\pm$ 10.63	11.80 $\pm$ 5.21	17.92 $\pm$ 2.79	15.00 $\pm$ 3.31
Lymphocyte	%	54.83 $\pm$ 5.67	41.18 $\pm$ 7.56	40.16 $\pm$ 10.30	44.73 $\pm$ 9.62
Eosinophil	%	0.00 $\pm$ 0.00	0.66 $\pm$ 0.41	1.24 $\pm$ 0.68	0.03 $\pm$ 0.05
Basophil	%	0.35 $\pm$ 0.19	0.45 $\pm$ 0.16	0.47 $\pm$ 0.12	0.36 $\pm$ 0.05
RBC	$10^6/\mu\text{l}$	3.47 $\pm$ 0.84 ^a	6.93 $\pm$ 0.73 ^b	6.70 $\pm$ 1.82 ^b	8.37 $\pm$ 0.51 ^b
Hematocrit	%	14.03 $\pm$ 4.15 ^a	34.95 $\pm$ 5.71 ^b	36.02 $\pm$ 8.53 ^b	45.13 $\pm$ 3.60 ^b
Platelet	$10^3/\mu\text{l}$	1374 $\pm$ 881 ^a	655 $\pm$ 335 ^b	453 $\pm$ 177 ^b	477 $\pm$ 119 ^b

^{a,b} Values with different superscripts are significantly different ($p<0.05$).

Table 2. Normal serum biochemical constituents in miniature pigs (Mean $\pm$ SD)

	Unit	4 weeks	8 weeks	12 weeks	20 weeks
GGT	IU/l	54.75 $\pm$ 8.54 ^a	93.10 $\pm$ 29.86 ^a	96.44 $\pm$ 36.61 ^b	83.25 $\pm$ 28.93 ^a
AST	IU/l	42.50 $\pm$ 18.27	6.09 $\pm$ 40.11	34.44 $\pm$ 25.37	20.75 $\pm$ 4.35
ALT	IU/l	13.50 $\pm$ 3.32	8.91 $\pm$ 13.09	35.22 $\pm$ 19.76	30.50 $\pm$ 2.38
Amylase	IU/l	1209 $\pm$ 122	1237 $\pm$ 285	1622 $\pm$ 263	1801 $\pm$ 376
BUN	mg/dl	12.65 $\pm$ 2.44	11.06 $\pm$ 4.56	11.98 $\pm$ 4.69	15.13 $\pm$ 5.90
Glucose	mg/dl	109.25 $\pm$ 33.86 ^a	78.73 $\pm$ 11.77 ^b	100.38 $\pm$ 14.98 ^a	118.00 $\pm$ 44.94 ^a
Phosphate	mg/dl	10.33 $\pm$ 1.14	8.18 $\pm$ 1.61	10.53 $\pm$ 0.82	13.23 $\pm$ 2.20
Calcium	mg/dl	9.95 $\pm$ 0.99	9.74 $\pm$ 0.86	10.93 $\pm$ 1.20	9.43 $\pm$ 0.12
Albumin	g/dl	4.35 $\pm$ 0.25	4.33 $\pm$ 0.54	4.76 $\pm$ 0.32	4.63 $\pm$ 0.15
Cholesterol	mg/dl	119.00 $\pm$ 15.73	110.50 $\pm$ 23.33	136.88 $\pm$ 125.63	131.50 $\pm$ 55.26
Creatine kinase	mg/dl	NA	531 $\pm$ 209	469 $\pm$ 215	61 $\pm$ 34
Creatinine	mg/dl	0.58 $\pm$ 0.39	1.26 $\pm$ 1.91	0.77 $\pm$ 0.26	1.08 $\pm$ 0.41
T-bilirubin	mg/dl	0.48 $\pm$ 0.19	0.37 $\pm$ 0.23	NA	NA
T-protein	g/dl	6.83 $\pm$ 0.51	7.98 $\pm$ 1.08	8.29 $\pm$ 0.85	8.83 $\pm$ 0.66
Globulin	g/dl	2.48 $\pm$ 0.28	3.67 $\pm$ 1.19	3.51 $\pm$ 0.80	4.10 $\pm$ 0.78

GGT: gamma glutamyl transferase, AST: aspartate aminotransferase, ALT: alanine aminotransferase, BUN: blood urea nitrogen
NA: not available

^{a,b} Values with different superscripts are significantly different ($p<0.05$).

Table 3. The change of body weight, waist circumference, and height during growing period in miniature pigs (Mean $\pm$ SD)

	Unit	4 weeks	8 weeks	12 weeks	20 weeks
Body Weight	kg	2.39 $\pm$ 0.60 ^a	4.44 $\pm$ 1.19 ^b	7.68 $\pm$ 2.09 ^c	13.81 $\pm$ 1.26 ^d
Waist circumference	cm	27.50 $\pm$ 2.08 ^a	37.73 $\pm$ 2.87 ^b	43.44 $\pm$ 3.71 ^c	55.56 $\pm$ 2.51 ^d
Body height	cm	34.56 $\pm$ 2.60 ^a	44.82 $\pm$ 3.19 ^b	55.00 $\pm$ 6.04 ^c	67.89 $\pm$ 3.82 ^d

^{a,b,c,d} Values with different superscripts are significantly different ($p<0.05$).

values except GGT, were in accordance with the values reported by other researchers [2,3,7-9,11,12,15]. So we have found that these values of blood and blood chemicals in PWG pigs are similar to those obtained in other species pigs.

Differences in biochemical and hematological parameters in swine of different ages are well documented by Friendship et al. [7], Tucker et al. [13], and Dubreuil and Lapierre [3]. In these 3 reports, they have reported the some values show different values significantly ($P < 0.05$), but these are fall within the normal limit. For the variation of these values, they said that the age is an important source of variation for some of the parameters and the other factors of sex, genetics, rate of growth, diet and feeding methods have been shown to influence certain biochemical parameters. In our experiments, although we have some different values in RBC, hematocrit, platelet, GGT and glucose, except RBC and hemocrit in different ages, age is thought not to be the major source of these variation.

In hematological values, the values of RBC in the 4-week group show lower level compare to the other age groups. This phenomenon is mainly due to the early anemia. Because the growth rate of pigs from birth to weaning at 21 days has increased dramatically. This anemia is transient and physiological regenerative anemia with iron deficiency [4,5,9]. In our experiments, early anemia was shown in the early days. After 4 weeks, the values of RBC and hematocrit in our experiment increased to normal ranges [6,13].

In Dubreuil and Lapierre's report of growing pig (Yorkshire-Landrace pigs) [3], aged between 8 to 20 week, the creatinine, protein, albumin and cholesterol increased and the AST and alkaline-phosphatase decreased during the same period. But these changes are variations within normal limits.

In our experiment of biochemical values, the GGT increased during 8,12 and 20 weeks of age ($P < 0.05$), others show no significant changes during growing period. And as the GGT values are over the normal limit (20- 60 unit/l), more experiments are needed for these different values.

In Tucker et al.'s report [13] in pigs of 4-21 weeks of age, the majority of measured parameters and values obtained from QPF (qualified pathogen free) pigs were found to fall within previously published referenced ranges. However, WBC, glucose, globulin, GGT and hemoglobin values show above or below the reference range. Especially the serum globulin shows reduced concentration for QPF pigs, irrespective of age, when compared with conventional pigs.

And this findings were considered to be a further indication of the relatively limited exposed of the QPF pigs to pathogens in their environment. And they thought that the cause of the increased level of glucose was due to ketamin-induced hyperglycemia. But in our experiment, the glucose level shows the lowest only in the 8-week group ($P < 0.05$) and as blood sampling was taken before anesthesia, so this value of glucose level was thought to be not associated with anesthetic agent.

In body weight, waist and height of Table 3, as they grow they show significant increase during growing period in miniature pigs.

In summary, the data presented in this paper provides a baseline for interpreting hematological and biochemical results during growth period in PWG miniature pigs and these data would be useful for researchers as well as clinicians.

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초록 : 성장 미니돼지의 혈액 및 혈청화학 성분의 연구

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본 실험의 목표는 미니돼지에서 성숙 전까지의 성장단계에서 혈액성분을 조사하는 것이다. 12마리 돼지를 이용하여 정맥에서 채혈하였다. 전혈과 혈청을 사용하여 혈액 및 혈액 화학치를 분석하였다. 그리고 성장단계별의 조사에서 각 성분은 평균과 표준편차로 나타내었다. 혈액분석에서 적혈구와 적혈구용적 그리고 혈소판에서 유의치 있는 변화가 있었다. 특히 적혈구와 적혈구용적은 4주령 군에서 가장 낮은 수치를, 반면에 혈소판은 4주령에서 가장 높은 수치를 보였다. 혈액 화학치에서는 glucose, GGT에서 유의치 있는 변화가 있었으며, 나머지 성분에서는 유의치 있는 변화가 없었다. 이러한 기본적인 혈액 및 혈액 화학치는 미니돼지의 정상 혈액학 연구와 그리고 성장단계별 이른 시기에 정상돼지를 판별하는데 유용하리라 생각된다.