Plasma CPK as an Indicator of Stress Susceptibility in Swine

Charles V. Maxwell, R. P. Wettemann and L. E. Walters

Story in Brief

A total of 18 pigs from litters in which one or more littermates died from stress were used to study the effect of sampling technique and exercise on plasma creatine phosphokinase (CPK). Plasma CPK in stress susceptible pigs was compared to CPK concentration in 7 control pigs with no history of stress.

Plasma CPK was similar in samples obtained from cannulae and first and second samples obtained via puncture of the anterior vena cava. This suggests that blood samples can be obtained by a variety of methods for CPK determination if care is used in the collection procedure.

Stress susceptible pigs had higher CPK values than control pigs and the CPK increase following exercise was much greater in stress susceptible than in control pigs. Plasma CPK after exercise increased to more than 100 sigma units/ml in 41% of the stress susceptible pigs, reaching maximum concentrations by 8 hours after exercise. These studies indicate that if blood CPK is used as an indicator of stress susceptibility, differences between susceptible and non-susceptible pigs can be greatly magnified by a standard exercise prior to samplings.

There was no significant difference in transmission values among the control pigs, stress susceptible pigs with high CPK or the stress susceptible pigs with low CPK. However, stress-susceptible pigs tended to have higher transmission values.

Introduction

The incidence of an acute, shock-like syndrome induced by a number of stressors, such as rapid change in temperature, mild exercise or fighting, has been reported extensively in swine during the past few years. We have been involved for several years at OSU in attempting to develop methods for early identification of stress susceptibility. It has been suggested that increased cell membrane permeability to enzymes such as creatine phosphokinase (CPK) results in the presence of this non-plasma-specific enzyme in blood plasma. Since muscle cell changes are usually associated with the stress syndrome, plasma CPK may be useful in identifying stress susceptible swine. Research data is available

which suggests that stress susceptible pigs have a higher concentration of CPK than non-susceptible pigs. In general, our studies agree with these findings, however, we have observed a very large within pig variation in plasma CPK values.

The purpose of this study was to investigate some of the possible factors which could result in the observed variation in plasma CPK. We were also interested in determining if plasma CPK values obtained after a standard exercise period were a better estimate of stress susceptibility than values obtained before exercise.

Experimental Procedure

A total of 18 stress susceptible and 7 control pigs were used in this study. Stress susceptible pigs were purebred Yorkshires from litters which had one or more pigs die of stress. Since two stress susceptible pigs died during our exercise treatment, we felt that these represented a truly stress susceptible group of pigs. Control pigs used in this study were purebred Hampshires with no history of stress.

The pigs were housed in confinement and managed in a conventional manner until they reached approximately 230 pounds. Then the pigs were assigned to the experimental procedure outlined as follows:

Day 1 — The pigs were anesthetized with sodium thiopenthol and indwelling cannulae were placed in the anterior vena cava.

Day 9 — Plasma samples were obtained from the cannula and from the first and second syringe of blood obtained from a single puncture of the anterior vena cava. This was done to determine if the method of obtaining blood had any effect on plasma CPK values.

Day 11 — Pigs were exercised for 45 minutes on a treadmil moving at approximately 1 mile/hour. Plasma samples were collected at one hour before exercise and frequently for 48 hours after the initiation of exercise.

Day 20 — Pigs were slaughtered and transmission values (a measure of protein solubility) were determined on the longissimus dorsi muscle at the 10th rib.

Results and Discussion

Plasma CPK concentrations were not significantly different when samples were taken at 8 a.m., 12 a.m., 6 p.m. and 12 p.m. (Table 1). This suggests that there is no apparent diurnal variation in plasma CPK under our experimental conditions.

Although samples from cannulae were slightly less concentrated, no large differences in plasma CPK were observed between samples obtained by cannula or from the first or second syringe of blood obtained via anterior vena cava puncture (Table 2). Since CPK values were not elevated in the first syringe of blood, this suggests that very little muscle contamination occurred in the sampling process. Apparently, anterior vena cava puncture can be used as a method to collect blood for CPK determination. It should be noted, however, that these anterior vena cava samples were obtained by an experienced technician.

The effect of exercise on plasma CPK is summarized in Figure 1. Stress-susceptible pigs had higher CPK values than control pigs. In

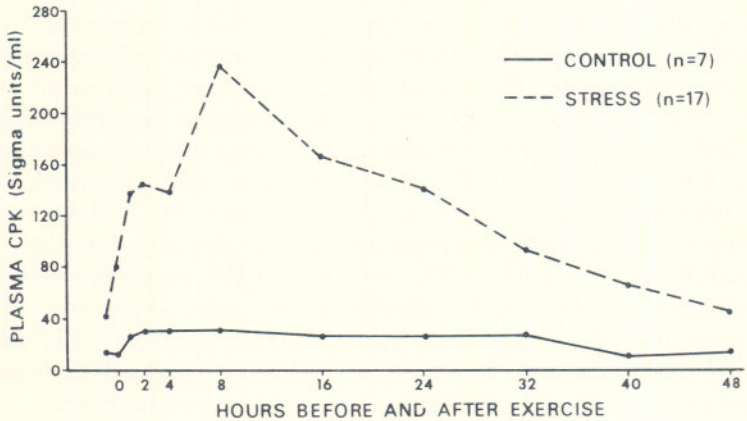

Figure 1. Effect of Exercise on Plasma CPK.

Table 1. Daily Variation in Plasma CPK in Swine.

Time	No. samples	CPK
8 a.m.	25	51.1
12 noon	25	52.4
6 p.m.	25	48.4
12 p.m.	25	68.4

Table 2. Effect of Sampling Technique on Plasma CPK in Swine.

Sampling method	CPK
Cannula	43.7
Anterior Vena Cava	
First sample	59.0
Second sample	62.5

addition, the increase in plasma CPK following exercise was much greater in stress susceptible pigs than in control pigs. In the control pigs, there was approximately a two-fold increase in CPK by two hours after exercise. However, in stress susceptible pigs, plasma CPK increased approximately six fold and reached a maximum at about 8 hours after the initiation of exercise. Then plasma CPK concentrations gradually decreased. This suggests that for maximum differences between control pigs and stress susceptible pigs, all pigs should be exposed to a standard stress and sampled at a standard time following stress.

Not all stress susceptible pigs responded with an increase in CPK after stress. Figure 2 separates stress susceptible pigs into those which had a maximum CPK greater than 100 sigma units/ml after stress (high CPK) from those with a maximum CPK value of less than 100 sigma units/ml (low CPK). Approximately 41% of the stress susceptible pigs responded with high CPK activity following exercise. It is interesting to note that CPK values for the low CPK stress susceptible swine are no higher than for control pigs. The largest increase in CPK from one hour before exercise compared with after exercise value is approximately a two fold increase in CPK activity. However, CPK increased 7 fold after high CPK stress susceptible pigs were exercised. Therefore, the difference between CPK concentrations in the control or low CPK stress susceptible swine and high CPK stress susceptible swine increases from approximately a three fold difference at one hour stress to a 13 fold difference in CPK activity at 8 hours following exercise. This suggests that the difference in CPK activity in pigs which respond to stress can be greatly magnified by sampling following a standard stress. Swine producers who are attempting to obtain blood samples for evaluation of stress susceptibility would have a better chance to identify the susceptibile pigs within a herd if all pigs were exposed to a standard stress approximately 8 hours prior to sampling.

Although CPK increases in the plasma in some stress susceptible pigs after exercise, it may not increase in all pigs. Even with better standardization of sampling procedures, it is still doubtful that plasma CPK will be a real efficient method to eliminate stress susceptibility in swine herds.

Percent transmission values for the control pigs, high CPK-stress susceptible pigs and low CPK stress susceptible pigs are shown in Table 3. The high CPK stress susceptible pigs tended to have the highest transmission values. Since high transmission has been associated with a higher incidence of poor quality muscle tissue, this would suggest that the high CPK may be used to identify pigs which will have poorer quality pork.

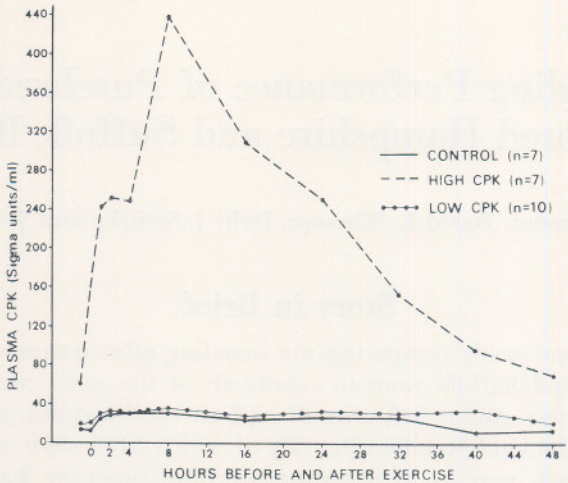

Figure 2. Effect of Exercise on Plasma CPK.

Table 3. Transmission Values of Longisimus Dorsi Muscle in Swine.

	No.	% Transmission
Control	8	48.3
High CPK-SS	4	70.6
Low CPK-SS	7	49.5