PARATHYROID HORMONE, CALCIUM AND PHOSPHORUS RELATIONSHIP PRE-AND POSTPARTUM IN COWS AND THEIR CALVES IN POSTNATAL PERIOD

N. A. Heakal S. A.; Siam A. A.*; Ismail A. A.* and El-Seady Y.

Department of physiology. Faculty of Veterinary Medicine. Mansoura University. Egypt.

Department of physiology. Faculty of Veterinary Medicine Suez Canal University*, Egypt.

ABSTRACT

The present investigation was carried out on 15 early parturient Holstein Friesian calves from one day old age till 23 weeks in addition to their dams in pre and post calving period.

Blood samples were collected in heparinized tubes from dams within four days prepartum and in the same day of calving, blood samples from calves were collected in different periods, just after calving (before colostral feeding) then weekly from the first week till the third one, then two week interval, till 9th week. The weaning samples were taken in 10th and 11th, then monthly till 23 weeks age. The parathyroid hormone PTH was measured by radioimmunoassay method, also total calcium and inorganic phosphorus were estimated .

The results of plasma PTH in calves showed that, the lowest level was after calving (before colostral feeding) then begin to significantly increase at one week age and these high level persist all over the suckling and till the end of 10th week then return to its high level . In the weaning age and at 11th week of age PTH level was significantly decreased, after that it begin to increase again till 23 weeks age. There was non significant change in calves plasma total calcium level during the period of study, butthere were a slight gradually decrease in its levels begin from 12.53±1.35mg/dl at calving to 10.13±0.24 mg/dl at 23 weeks of age . Plasma inorganic phosphorus level in calves revealed a significant changes in different age periods to reach the highest level (6.51±0.29 mg/dl) in the weaning period at age 11 week.

The results revealed that, PTH was significantly increased in dams after calving that before calving, a significant decrease in total calcium in the plasma of dams after calving than that before calving. There was non significant change in inorganic phos-

phorus in dams before and after calving .

It was concluded that, the age and weaning affect the levels of PTH in calves, the calving process and the beginning of milk secretion considered as physiological events that affect the activity of parathyroid gland in dams . Also the relationship between PTH and age during suckling, weaning and growing periods may reflect the change in the sensitivity and even responses of the parathyroid gland and existence of interaction between some physiological events and environmental factors.

INTRODUCTION

Parathyroid hormone (PTH) is the principle hormone involved in fine regulation of blood calcium in mammals it exerts its biologic action on bone, kidney and intestine, the important action of PTH on bone, is to mobilize calcium from skeletal reverses into extracellular fluids, which is mediated by osteoclasts thats primarily responsible for long term action of PTH on increasing bone resorption and overall bone remolding **(Canalis et al., 1994)**. In calves, **Coxam et al., (1990)** noted that, anabolic effect of PTH on bone is mediated by an increase in hepatic IGF-I production . Moreover, PTH has a direct and rapid effect on renal tubules, it decrease reabsorption of phosphorus in the proximal tubules, as well as it increases excretion of potassium, bicarbonate and sodium, but it block the calcium excretion by increasing the absorption in distal tubules, in addition the conversion of cholicalceferol into active metabolites **(Yanagawa and Lee 1992)**. Calcium transport across the gastrointestinal tract of mammals is not believed to be affected firstly by PTH but only indirectly by regulating the renal production of calciferiol **(Fraser et al., 1987)**. However, **Dua et al., (1994)** concluded that both PTH and parathyroid related protein (PTH-rP) influence calcium and phosphorus homeostasis in sheep not only by their action in bone and kidney but also an absorption of calcium from the forestomach.

Newborn calves showed detectable levels of plasma PTH at birth similar to that found in their mothers **(Garel and Barlet 1976)**. In contrast, the plasma calcium concentration of the neonatal calves at calving is higher than maternal concentration and also PTH levels **(Baretal.,1988)**, thenormal calcium level in fetal calves was higher in comparison with adult **(Coxam et al., 1988)**. The fetal parathyroid gland and placental membranes were very important in PTH-rP secretion **(Abbas et al., 1990)**. The concentration of PTH-rP in cow s milk increase with the duration of lactation, where PTH-rP carrying on into newborn calves and its physiological role in making calcium available during calves development have been suggested by **Raticli. et al., (1992)**. The

secretory rate of PTH in normocalcemic calves was established by **Mayer and Hurst (1978).** There was a sigmoidal relationship between PTH secretory rate and plasma calcium level in parturient cow **(Blum et al., 1974).** Moreover, **Rawia et al., (1987)** reported that, the age of the calves has a significant effect on blood calcium and inorganic phosphorus level but the sex has no significant influence **Engstrom et al., (1987)** found that, decreasing in plasma phosphorus and increasing in 1.25 (OH) 2 D in calves are associating with PTH treatment. The secretion of PTH is in turn regulated by calcium ions (**Pocoette et al., 1995)** and magnesium : **(Hitoshi et al., 1997).**

The aim of this study was directed to determine the bone forming elements as total calcium and inorganic phosphorus in the newly born and growing calves and their dams pre- and post-partum period in relation to parathyroid gland activity.

MATERIALS AND METHODS

The present study was carried out on fifteen Friesian calves and their dams of known gestation period weighting (400- 500) Kg. Each calf was delivered spontaneously at term of normal gestation period (278-283) days with a birth weight 402 Kg. Immediately after birth the calves were separated from their dams and housed in doors in an individual pens, they were fed twice daily at 7 am and 5 pm with maternal colostrum during the first two day of post natal life, then with the whole milk 10% from body weight) was offered using artificial nipples from the third day till weaning (9 weeks of age); from the third week, in addition to the milk, a mixture of grained corn and protein supplement in the form of skimmed milk (3% from concentrate) was provided with alfa alfa hay up to the age of weaning. The same mixture was provided to growing calves till the end of the work (at 6 month).

All the animals were in a good health as demonstrated by investigation of daily weight gain and continuous clinical examination.

Blood samples were collected from calves and their dams from jugular vein periodically in the following manner:

Samples from calves and their dams

Just after calving within five hours before colostral feeding, weekly till 3rd week ,two weeks interval until weaning at 9th week, two samples with one week interval 10th and 11th, representing weaning period and monthly after weaning up to 6th month, representing growing period . Blood samples were collected from dams within the last four days prepartum, as well as, at the same day of calving .

Biochemical and hormonal assay :

Parathyroid hormone was measured by radioimmunoassay (RIA) using kits according to the method adapted by **Yalow and Berson (1971)**. Plasma calcium was determined by direct calorimetric method using a kit supplied by Diamond diagnostic kit company according to Tietz (1970). The plasma inorganic phosphorus was determined calorimetrically using kit supplied by Biomerieux diagnostic kit company according to **Taussky et al., (1953)**. The statistical analysis were done according to **Snedecor and Cochran (1967)** using student t and F tests with the application of correlation coefficient.

RESULTS AND DISCUSSION

The result of plasma levels of PTH, Calcium (Ca) and phosphorus (P) in calves are shown in table (1) and the same parameters in dams pre and post calving are shown in table (2).

The result of this study revealed that the lowest concentration of PTH (0.62 ± 0.20 ng / ml) had been observed in new natal calves just after calving and before suckling of colostrum (table 1). This observation of parathyroid hypoactivity may be due to neonatal hypercalcaemia observed in this study. The mammalian fetus is maintained hypercalcaemic relative to its mother by the action of the calcium pump (**Abbas et al., 1990**). The total plasma concentration of PTH and PTH-rP is inversely related to the prevailing calcium ions concentration but the set point of PTH-rP is probably higher than that for PTH (**Care, 1989**). In spite of neonatal hypercalcaemia, plasma PTH was also higher than the maternal one, this result support the suggestion made by **Keaton et al., (1978)**. The plasma Ca concentration, below which the increase in PTH secretion can be observed, is set at a higher concentration in the neonate, these results coincide with the results of **Garel and Barlet, (1976)** which indicated that new born calves showa detectable levels of plasma PTH at birth similar to that found in their mothers. In contrast, the present study disagree with the results observed in the mothers, where the PTH concentration in the dams plasma is found to be higher than their calves (Table 1). Plasma concentration of PTH was found to be higher in fetal lamb than its mothers, confirming the previous observation of **Care et al., (1985)**. Other studies have shown similar rates of clearance of PTH in the fetal sheep and in its mother, whereas, clearance rates were higher in fetal sheep than in their mothers (**Ratcliffe et al., 1993**). In calves 1 to 3days old **Keaton et al., (1978)** reported increased plasma calcium and decreased PTH secretion rate when the calcium between 9.5 and 12 mg / dl, at such concentrations, PTH secretion rate and plasma calcium were concentration in the present study during suckling., weaning and growing period (r 0.88 and -1) respectively. The study suggests that, hypercalceamia in new born calves may be a form of hypoparathyroidism,

It was found that, PTH in this study starts to increase at one week of age and stabilize at high level during the period of suckling. Except a transient decrease had been observed at 5th week of age (fig. 1) The precise cause of this inhibition of the hormone activity not well known and can be interpreted. Since the role of PTH is mainly to protect against hypocalcaemia **(Riggs, 1966)**. It is not awaking to observe an asymmetrical response of the parathyroid gland to calcium level, where as, the calcium concentration in suckling period have not been appeared any significant changes (table1). This data agree with similar results of **(Mayerand Hurst, 1978)**, the failure to suppress PTH secretion during periods of hypercalcaemia suggests the maintenance of a basal secretory rate that is independent of plasma calcium concentration. This, together with minimal changes in secretion rate through the normocalcaemic range, may explain the occasional lack of correlation between concentration of PTH and calcium level in the peripheral blood. Furthermore, the present results suggest the report of **(Luts and Sundler, 1997)**, where level of PTH increased at 3 to 4 weeks after birth in rats. It seemed likely from the results that, PTH concentration is significantly lower at the weaning period, where milk was deprived completely from calve s feeding, this parathyroid hypoactivity may be attributed to stress that have been existed upon calves after weaning. These results agree with the suggestion of **Buonaccorsi et al., (1972)**, that the cortisone treatment contributed to the parathyroid insufficiency in calves.

After weaning, the calves feed formulated ration containing mineral mixture containing calcium salts. The developing bone appeared to be have a great demand of calcium for building up. Where as, the PTH again starts to increase during the growing period at 15 weeks of age as detected in the present results . This stepwise increase in PTH concentration appeared to stimulate bone formation and provide the great requirement of calcium to growing bone. These results were in parallel with the previous experimental data that indicated that bone formation may also be stimulated by PTH **(Vaughan, 1975)**. These observations suggest that, there is coupling between bone resorption and bone formation under the influence of high blood level of PTH, one can conclude that the changes in bone formation and resorption at the tissue level under the influence of physiological doses of PTH are coupled and balanced. Furthermore, the observed changes reflects steady state effects and not a transient phenomenon. **(Hartmut et al., 1982)** The variation in correlation coefficient in the PTH versus age reflects the asymmetrical response of parathyroid gland **(Mayer and Hurst, 1978)**. Whereas, several secratoguges and cations regulates PTH secretion **(Fitzpatric 1991, Brown et al., 1993)**.

The plasma level of PTH in dams was higher significntly after calving than observed before calving (Table 2) . These results concides with the results obtained by **Hollis et al., (1981)** and **Habener et al., (1984)** that, hypocalcemia at parturition probably induced the secretion of PTH .Moreover, plasma calcium concentration was lower than before calving as indicated by this re-

suit . These results was inagreement with the previous results of **BaLntin and Habener (1989)** Who reported that plasma calcium level as well as PTH would decreased with parturition. The high PTH after parturition, together with the decreased plasma calcium appear to account for the increased kidney production of 1.25 (01l) 2D3 **(Habener et al., 1984)** and its accumulation in the plasma **(Bar et al., 1988)**. Lactation represents a physiological situation of calcium and inorganic phosphorus stress for high yielding dairy cows. In order to supply these large quantities of calcium and phosphorus required for milk production, there is an important increase in mobilization of these minerals from the gut and bone of lactating cows **(Ramberg et al., 1984)**. Indeed, blood concentration of PTH is elevated in lactating cows **(Hove 1986)**. However, **Barlet et al.,(1993)** suggested that, PTH not only a factor involved in lactation stimulated bone mineral mobilization and intestinal calcium and phosphorus absorption . The data will also confirm the previous results of **Martin et al., (1996)** in mare, where, serum PTH peak and calcium nadir occurred on day two postpartum, one day later than reported previously in dairy cows.

The plasma calcium level in calves was presented in table II) .It was found that , there was no significant changes could be detected during the entire period of study. In spite of, stepwise decrease corresponding the advancement of age fig (1). The results was parallel with **Vankatarman, (1992)** Who found, no significant differences in serum calcium among infant in different ages till 26 weeks postnatal. Similarly, new born lambs and calves did not show changes in the plasma calcium **(Garel and Barlet 1976)** . In contrast, in new born rats a decreased in plasma calcium concentration was observed within 2 hrs after delivery and then increased between 12 and 36 hrs after birth. In newborn foals, as light hypocalcemia occur within 48 hrs after birth **(Garel and Barlet 1976)** .

The plasma calcium level in dams are shown in table (2), calcium level after calving appeared to be lowered than that before calving associated with increase PTH concentration. The hypocalcemia at parturition probably induce the secretion of PTH **(Hollis et al., 1981 and Habener et al., 1984)**

The plasma levels of P in calves were presented in table (l). It was appeared that, the lowest level was observed just after calving and during the first 2 weeks . These transient hypophosphatemia may be attributed to the effect of PTH -rP where it found in high concentration in mammary vein **(Ratcliffe et al., 1992)** and in milk **(Budayr et al., 1989)** is able to stimulate excretion of P in urine **(Barlet et al., 1993)**. In the contrary, the results disagree with the data of **(Garel and Barlet 1976)** Who reported that, plasma phosphorus concentration in new born rats, foals the formulated ration provided at this age. In addition, the high level of PTH at third week may contributed in the stimulation of phosphate absorption **(Dua et al., 1994)** . At weaning the calves were depend completely upon formulated ration rich in phosphorus resulted in increase

In phosphorus level in plasma. These results parallel to the similar studies of **Speackers et al ., (1986)** The level of phosphorus in dams as presented in table (2) do not revealed any significant changes after calving than that s its level before calving, this may be contributed to the regulation by PTH -rP. **(Ratcliffe et al., 1992).**

It was concluded that, the age and weaning affect the levels of PTH in calves, the calving process and the beginning of milk secretion considered as physiological events that affect the activity of parathyroid gland in dams. Also the relationship between PTH and age during suckling, weaning and growing periods may reflect the change in the sensitivity and even responses of the parathyroid gland and existence of interaction between some physiological events and environmental factors.

Table 1 : The plasma levels of PTH (ng/ml) , Ca (mg/dl) , and P (mg /dl) in calves.

Period	Suckling							Weaning		Growing		
age/w	0	1	2	3	5	7	9	10	11	15	19	23
PTH	0.62 ± 0.20	1.08 ± 0.12	1.15 ± 0.23	1.18 ± 0.47	0.89 ± 0.20	1.11 ± 0.14	1.07 + 0.14	1.05 ± 0.16	0.81 ± 0.7	0.97 ± 0.21	1.27 ± 0.15	1.38 ± 0.15
Ca	12.53 ± 1.35	12.56 ± 0.79	12.08 + 0.52	11.38 ± 0.40	11.76 ± 0.27	11.41 ± 0.20	11.98 ± 0.34	11.55 ± 0.45	10.80 ± 0.52	10.78 ± 0.34	10.56 ± 0.40	10.13 ± 0.24
P	5.4 ± 0.12	5.43 ± 0.18	5.08 ± 0.47	6.41 ± 0.31	5.35 ± 0.29	5.85 ± 0 35	6.31 ± 0.17	6.40 ± 0.51	6.51 ± 0.29	6.30 ± 0.18	6.38 ± 0.22	6.31 ± 0.45

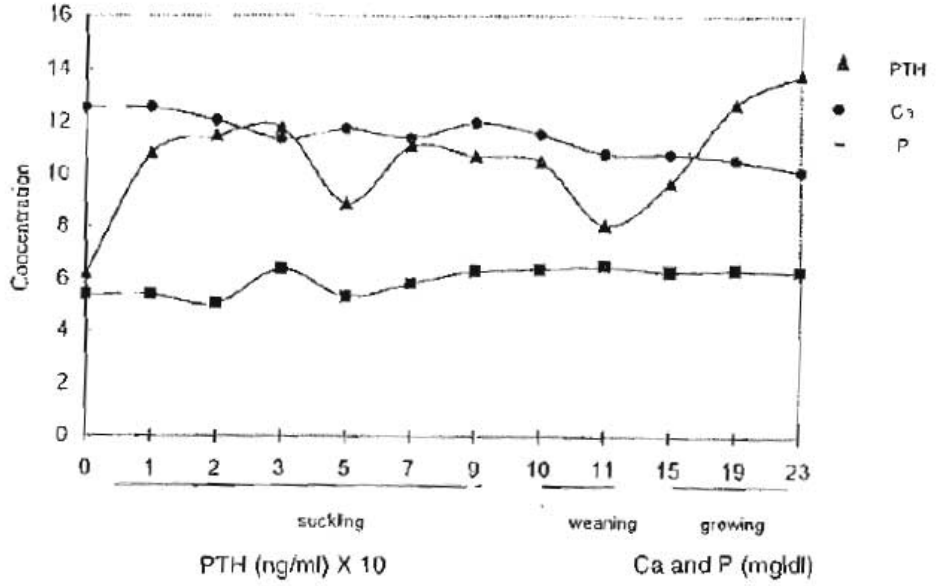
Mean ± S.E. LSD for PTH at P<0.05=0.41 at P<0 01=0.59 LSD for P at P<0.05 = 0.77 at P<0.01 = 1.09

Table 2 : The plasma levels of PTH, Ca and P in dams pre and after calving.

Parameters	Before calving	After calving
PTH	0.91 ± 0.11	1.39 ± 0.16**
Ca	11 ± 0.29	9.6 ± 0.68*
P	5.28 ± 0.35	5.09 ± 0.3

* Significance at p<0.05. ** High significance at p<0.01.

Fig. 1 : Plasma levels of P, Ca and PTH in calves during suckling ,weaning an growing period.



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الملخص العربى

العلاقة بين هرمون الباراثورمون والكالسيوم والفوسفور فى الأبقار قبل وبعد الولادة وفى العجول فى مراحل مابعد الولادة

المشتركون فى البحث

نبيل أبوهيكل سيد أحمد و عادل عبدالحميد صيام*

و أحمد عبدالفتاح إسماعيل و يوسف الصعيدى

قسم الفسيولوجيا - كلية الطب البيطرى - جامعة المنصورة

قسم الفسيولوجيا - كلية الطب البيطرى - جامعة قناة السويس*

إستهدفت هذه الدراسة معرفة مدى تغير مستوى هرمون الباراثورمون فى العجول الصغيرة وماتمر به من حالات فسيولوجية كمرحلة مابعد الولادة والرضاعة والفطام وكذلك فترة مابعد الفطام وعلاقة ذلك ببعض العناصر الهامة التى تدخل فى تكوين العظام وكذلك دراسة مستوى هذه العناصر فى الأمهات قبل وبعد الولادة مباشرة. إشتملت الدراسة على عدد ١٥ عجل حديثى الولادة من سلالة الفريزيان الهولوشتاين من عمر يوم وحتى عمر ٢٣ إسبوع بالإضافة إلى أمهاتهم فى الفترة ماقبل ومابعد الولادة. تم جمع عينات الدم من العجول بعد الولادة مباشرة قبل رضاعة السرسوب ثم أخذت العينات إسبوعياً من الإسبوع الأول وحتى الثالث ثم فى الإسبوع الخامس، السابع والتاسع ثم عند الفطام فى الإسبوع العاشر والحادى عشر، ثم عينات شهرية حتى عمر ٢٣ إسبوع. تم جمع عينات الدم من الأمهات فى خلال أربعة أيام قبل الولادة وكذلك بعد الولادة مباشرة. تم قياس مستوى كل من هرمون الباراثورمون والكالسيوم الكلى والفوسفور غير العضوى.

وقد أظهرت النتائج مايلى : بالنسبة لهرمون الباراثورمون فى الدجول وجد أن أقل مستوى له كان عند الولادة مباشرة وقبل رضاعة السرسوب ثم بدأ فى الزيادة المعنوية عند عمر إسبوع واستمر على هذا المستوى المرتفع طوال فترة الرضاعة وحتى نهاية الإسبوع العاشر مسجلاً نقصاً معنوياً مؤقتاً عند الإسبوع الخامس ثم عاد مرة أخرى إلى معدله، ولكن فى أثناء فترة الفطام عند الإسبوع الحادى عشر أظهرت النتائج نقص معنوى فى مستوى الهرمون ثم عاد بعدها فى الارتفاع مرة أخرى واستمر فى الزيادة ليصل إلى أعلى معدل له عند عمر ٢٣ إسبوع أظهرت الدراسة عدم وجود تغير معنوى فى مستوى الكالسيوم فى فترة البحث (٦ أشهر) إلا أنه من الملاحظ أن مستواه يقل بصورة طفيفة تدريجياً من عند الولادة حتى عمر ٢٣ إسبوع أظهرت الدراسة وجود تغيير معنوى فى مستوى الفوسفور فى مراحل العمر المختلفة ليصل إلى أعلى معدل له فى فترة الفطام. أوضحت النتائج أيضاً وجود زيادة معنوية فى مستوى هرمون الباراثورمون فى الأمهات

فى مرحلة مابعد الولادة عنها فى مرحلة ماقبل الولادة. ولوحظ عدم وجود تغيير ملحوظ فى مستوى الفوسفور فى الأمهات قبل وبعد الولادة.

من هذه الدراسة نستخلص أن العمر وعملية الفطام يؤثران على مستوى هرمون الباراثورمون فى العجول وأيضاً تعتبر عملية الولادة وبداية إفراز اللبن من العمليات الفسيولوجية التى تؤثر على نشاط الغدة الجار درقية فى الأمهات. وإن الاختلاف فى العلاقة بين هرمون الباراثورمون والعمر أثناء فترة الرضاعة والفطام والنمو يمكن أن تعكس مدى التغير فى حساسية أو إستجابة الغدة الجار درقية.