Haryana Vet. (March, 2020) **59(SI),** 102-104

Short Communication

PERIOD OF LUTEAL DOMINANCE DETERMINES THE FOLLICULAR WAVE PATTERN OF OESTROUS CYCLE IN CROSSBRED CATTLE

S. SATHESH KUMAR*
Department of Veterinary Gynaecology and Obstetrics,
Veterinary College and Research Institute, Tamilnadu Veterinary and Animal Sciences University (TANUVAS),
Tirunelveli – 627 358, India

Received: 06.08.2019; Accepted: 14.10.2019

SUMMARY

The study was carried out with the hypothesis that the luteal dynamics determined the follicular wave pattern of an oestrous cycle in crossbred cattle. Sequential ultrasonographic monitoring of follicular and luteal development was carried out in untreated oestrous cycles (n = 18) of crossbred cows. Out of 18 oestrous cycles studied, 12 cycles (66.7%) and six cycles (33.3%) exhibited three- and two-follicular waves, respectively. In cycles with three-follicular waves, the corpus luteum reached the maximum diameter significantly earlier and remained dominant for a significantly longer duration (6.9+0.6 days) when compared with cycles of two-follicular waves (5.2+0.6 days). The shorter period of luteal dominance in two-wave cycles would have favoured the prolonged persistence of second follicular wave dominant follicle as against the counterpart's atresia and emergence of third wave in three-wave cycles. Thus, it could be concluded that the period of luteal dominance determined the follicular wave pattern of an oestrous cycle and thereby the fertility of the cattle.

Keywords: Crossbred cattle, Follicular wave, Luteal dominance

When the ovarian activity is investigated in cattle, it is detected that folliculogenesis operate on a wave basis at 7 to 8 day intervals throughout the oestrous cycle (Ginther *et al.*, 1989). Two and three follicular wave patterns are common among the Indian crossbred cattle but their incidence during an oestrous cycle is highly variable and unpredictable (Sathesh Kumar, 2009). These variations in follicular wave patterns are one of the major contributory factors of fertility disturbances among the dairy cattle population. It was reported that oestrous cycles with three-follicular waves have better fertility than those with two-follicular waves (Townson *et al.*, 2002). Various factors govern the wide variations in the follicular developmental patterns during an oestrous cycle like the plane of nutrition (Murphy *et al.*, 1991), circulating endocrine status (Adams *et al.*, 1992) and season (Sathesh Kumar *et al.*, 2015). Ginther *et al.* (1989) reported that the time of luteal regression is one of the factors that determine the number of follicular waves during a cycle. In this row, we hypothesized that the overall luteal dynamics during an oestrous cycle have an important role in determining the numbers of follicular waves. Hence, the present research work was carried out to document the follicular and luteal turnover simultaneously during the oestrous cycle and to explore the possible impact of luteal dynamics over the incidence of various follicular wave patterns.

Six healthy and regularly cyclic Jersey crossbred multiparous cows (5 to 6 yrs) in the end of lactation, maintained at the Centralized Embryo Biotechnology Unit, Department of Animal Biotechnology, Madras Veterinary College, Chennai, were utilized for the study. All the cows were maintained under identical managemental conditions throughout the study.

Sequential and simultaneous ultrasonographic monitoring of follicular and luteal development was carried out in untreated oestrous cycles using a real time B-mode ultrasound scanner equipped with 7.5 MHz linear array transrectal transducer (SONOVET 600, SA-600V, Kretz Technik AG, Austria). The ovaries of each cow were examined every other day throughout an oestrous cycle starting from the day of observed oestrus (Day 0) to subsequent standing oestrus. The diameter (dm) of follicles and corpus luteum (CL) were recorded during each examination and their developmental turnover were sequentially drafted. The follicular wave pattern was determined by analyzing the day-to-day data as described by Sathesh Kumar *et al.* (2012). Luteal parameters viz., maximum diameter (mm), day of maximum diameter, growth and regression phase (days), growth and regression rate (mm/day) and period of luteal dominance (days) were recorded and compared between different types of follicular wave patterns. A total of 18 complete oestrous cycles were studied. The statistical significance between the data on different luteal parameters was carried out as per standard procedure (Snedcor and Cochran, 1994).

Out of 18 oestrous cycles studied, 12 cycles (66.7%) exhibited three-follicular waves, while the remaining six cycles (33.3%) had two-follicular waves. In general, the CL grew progressively until it attained the maximum diameter during the mid of the cycle and remained fluctuating around that size for a certain period (period of luteal dominance) before it started regressing constantly

*Corresponding author: drsatheshkumar6@rediffmail.com

towards the end of the cycle. The luteal characteristics in oestrous cycles with two-follicular waves and three-follicular waves were represented in Table 1 and Fig. 1. Perusal of the data revealed that the maximum diameter of CL was significantly ($P<0.05$) larger in three-follicular wave cycles than that of two-follicular wave cycles. In cycles with three-follicular waves, the CL reached the maximum dm significantly ($P<0.05$) earlier, remained dominant for a significantly ($P<0.05$) longer duration and started to regress non-significantly ($P>0.05$) later when compared with cycles of two-follicular waves. Thus, the period of luteal dominance was significantly ($P<0.05$) longer in three-follicular wave cycles than the two-follicular wave cycles.

The incidence rates of three- and two-follicular

Table 1

Characteristics of corpus luteum during two- and three-follicular waves

S.No.	Luteal parameters	Follicular wave patterns		Overall
		Three-waves (n = 12)	Two-waves (n = 6)	
1	Day of maximum diameter	9.0±0.5[a]	10.8±0.7[b]	9.5±0.4
2	Maximum diameter (mm)	22.1±0.4[b]	20.8±0.7[a]	21.7±0.4
3	Growth phase (days)	7.0±0.6	7.6±1.2	7.2±0.8
4	Growth rate (mm/day)	1.6±0.2	1.2±0.2	1.5±0.2
5	Period of luteal dominance (days)	6.9±0.6[b]	5.2±0.6[a]	5.7±0.6
6	Day of initiation of constant regression	16.2±0.7	15.2±0.4	15.2±0.8
7	Regression phase (days)	5.9±0.8	6.2±0.2	6.1±0.5
8	Regression rate (mm/day)	1.9±0.2	1.5±0.2	1.7±0.2

Values with different superscripts in each row differ significantly ($P<0.05$)

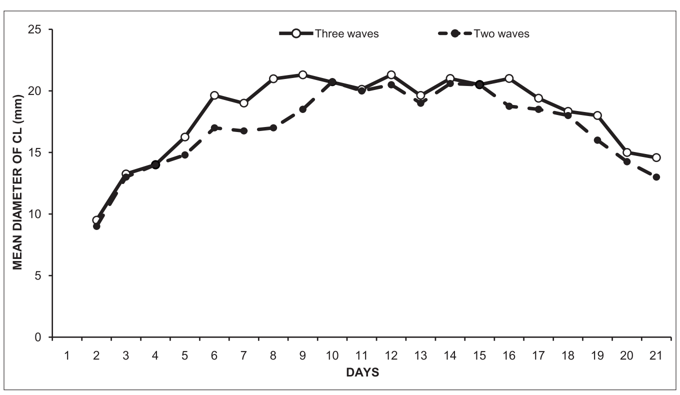

Fig.1. Luteal developmental patterns in two- and three-follicular wave oestrous cycles

waves during a cycle in the present study were 66.7 and 33.3% for, respectively. However, the authors in their previous study recorded 77.8 and 16.7% three- and two-follicular waves respectively in crossbred cows (Sathesh Kumar *et al.*, 2012). Thus, it is obvious that incidence of follicular wave pattern during a cycle is highly variable. CL is dynamic in that it exhibits regular episodes of growth, persistence and regression throughout the fertile reproductive phases. The mean maximum dm of CL recorded in our crossbred cows was in accordance with the observations of Taponen *et al.* (2000) in Finnish Ayrshire breed cows and heifers. Similar to our study, they also observed fluctuation around this dm till Days 14 or 15 before the initiation of constant luteal regression.

The early attainment of maximum dm and late regression of CL during a three-follicular wave cycle assured a significantly increased period of luteal dominance than the two-follicular wave cycles. Similarly, Townson *et al.* (2002) also observed that the length of the entire luteal phase (based on the progesterone concentration) was two days shorter in two- follicular wave cows than in three-follicular wave cows. It was observed that the CL was non-significantly larger in three-follicular wave cycles than that of two-follicular wave cycles. A positive association between plasma progesterone (P_4) concentration and CL size in the mid-luteal phase of dairy cows has been reported (Luttgenau *et al.*, 2011). Thus, the smaller CL in two-follicular wave cycles could be correlated with low circulating concentrations of P4 during mid luteal phase and vice versa in three-follicular wave cycles. Townson *et al.* (2002) recorded a high peak P_4 concentration in three-wave cycles than two-wave cycles which could be corroborated with luteal morphological findings of our study.

P_4 secreted by the CL negatively regulate pulsatile LH release from pituitary gland and inhibits the maturation and ovulation of the dominant follicle (DF) (Endo *et al.*, 2012). Thus the P_4 activity during the mid-luteal phase is a crucial factor that regulates the follicular development. It was observed that the CL was comparatively smaller and period of luteal dominance was significantly shorter in two-follicular wave cycles. Thus, it could be assumed that, under low P_4 concentrations (as observed by smaller CL), the increased LH pulsatile secretion would have supported prolonged sustenance of second wave DF in two-follicular wave cycles. Further, the endocrine environment due to early initiation of luteolysis would have favoured the second wave follicle to remain persistent and reach the ovulation stage in two-wave cycles. On the contrary, high P_4 concentrations (as observed by larger CL) and the ensuing LH suppression would have caused the regression of second wave DF and initiated the emergence of third wave in the three-follicular wave cycles. The third wave DF was benefitted from luteolysis and the consequent increasing LH pulse frequencies would have promoted final maturation and ovulation (Mihm and Austin, 2002).

Thus, it could be concluded that the period of luteal dominance and the associated luteal endocrine activity have a possible control over follicular turnover during spontaneous oestrous cycle in crossbred cows. Taking into consideration of the importance of mid cycle luteal support on embryonic sustenance and establishment of pregnancy, it is very obvious to associate the luteal insufficiency and prolonged persistence of second wave DF with the poor fertility in cows with two-follicular wave cycles.

ACKNOWLEDGEMENT

The work was carried out under the research project entitled "Regulation of follicular dynamics in crossbred cows for augmenting fertility and superstimulation," funded by Department of Biotechnology (BT/PR14687/AAQ/01/450/2010), Ministry of Science and Technology, Government of India, New Delhi, India.

REFERENCES

Adams, G.P., Matteri, R.L., Kastelic, J.P.,Ko, J.C.H. and Ginther, O.J. (1992). Association between surges of follicle stimulating hormone and the emergence of follicular waves in heifers. *J. Reprod. Fert.* **94**: 177-188.

Endo, N., Nagaia, K., Tanakaa, T. and Kamomae, H. (2012). Comparison between lactating and non-lactating dairy cows on follicular growth and corpus luteum development, and endocrine patterns of ovarian steroids and luteinizing hormone in the estrouscycles. *Anim. Reprod. Sci.* **134**: 112-118.

Ginther, O.J., Kastelic, J.P. and Knopf, L. (1989). Composition and characteristics of follicular waves during the bovine oestrous cycle. *Anim. Reprod. Sci.* **20**: 187-200.

Luttgenau, J., Ulbrich, S.E., Beindorff, N., Honnens, A., Herzog, K. and Bollwein, H. (2011). Plasma progesterone concentrations in the mid-luteal phaseare dependent on luteal size, but independent of luteal blood flow and gene expression in lactating dairy cows. *Anim. Reprod. Sci.* **125**: 20-29.

Mihm, M. and Austin, E.J. (2002). The final stages of dominant follicle selection in cattle. *Dom. Anim. Endocrinol.* **23**: 155-166.

Murphy, M.G., Enright, W.J., Crowe, M.A., McConnel, K., Spicer, L.J., Boland, M.P. and Roche, J.F. (1991). Effect of dietary intake on pattern of growth of DFs during the oestrus cycle in beef heifers. *J. Reprod. Fert.* **92**: 333-338.

Sathesh Kumar, S. (2009). Effect of synchronization of follicular wave emergence on superovulation and embryo yield in crossbred cows. Ph.D thesis submitted to Tamilnadu Veterinary and Animal Sciences University, Chennai, Tamilnadu, India.

Sathesh Kumar, S., Subramanian, A., Devanathan, T.G., Kathiresan, D., Veerapandian, C. and Palanisamy, A. (2012). Follicular and endocrinological turnover associated with GnRH induced follicular wave synchronization in Indian crossbred cows. *Theriogenology.* **77**: 1144-1150.

Sathesh Kumar, S., Brindha, K., Roy, A., Kathiresan, D., Devanathan, T.G. and Kumanan, K. (2015). Natural influence of season on follicular, luteal, and endocrinological turnover in Indian crossbred cows. *Theriogenology.* **84**: 19-23.

Snedecor, G.W. and Cochran, W.G. (1994) Statistical methods (8th Edn.) Iowa State University Press, USA.

Taponen, J., Rodriguez-Martinez, H. and Katila, T. (2000). Administration of gonadotropin-releasing hormone during metestrus in cattle: influence on luteal function and cycle length. *Anim. Reprod. Sci.* **64**: 161-169.

Townson, D.H., Tsang, P.C.W., Butler, W.R., Frajblat, M., Griel, L.C., Johnson, C.J., Milvae, R.A., Niksic, G.M. and Pate, J.L. (2002). Relationship of fertility to ovarian follicular waves before breeding in dairy cows. *J. Anim. Sci.* **80**: 1053-1058.