FACTORs INFLUENCING PERIpARTURIENT NEUTROPHIL FUNCTION IN DAIRY COWS

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Introduction

Many diseases and conditions of economic importance in dairy cattle occur most commonly during the immediate postpartum period. Kehrli et al found neutrophil function to be impaired during this period. These authors described periparturient depression of random migration, bacterial ingestion, chemiluminescence, iodination and cell-mediated cytotoxicity. In this study, heifers which had postparturient intramammary infections also suffered the most severe peripartum alteration of neutrophil function. This supports the contention that neutrophil function is an important element in the first-line defense of the body against bacterial infection. Impaired neutrophil function during the periparturient period may contribute to the peculiarly high incidence of bacterial infections during this period.

The incidence of disease in periparturient cows is further influenced by other factors, including parity and the occurrence of retained fetal membranes (RFM). Epidemiological studies have linked advancing parity to an increasing incidence of several disorders. Thus the lactational incidence risk of retained fetal membranes and ovarian cysts increased with advancing parity in a study of over 61,000 lactations in a population of Finnish Ayrshires. A separate study found that advancing age of dairy cows was associated with increased incidence of retained fetal membranes and mastitis. Retained fetal membranes, in turn, predispose to a host of other reproductive disorders including metritis, silent heat and undiagnosed infertility and mastitis. Even when controlling for the effects of specific, diagnosed diseases, advancing parity was associated with reduced reproductive efficiency. These authors speculate that this may be related to subclinical reproductive tract lesions. In itself, RFM is relatively innocuous. The retained membranes are unsightly, often fetid, and aesthetically objectionable for many milkers, but the effect of uncomplicated RFM on the cow is minimal. The major significance of RFM is in the mediation of more severe conditions. Thus, cows which have suffered retention of fetal membranes are at significantly increased risk for developing metritis, ketosis, mastitis and even subsequent abortion in the following pregnancy. Schukken, Erb and Smith studied the relationship between RFM and mastitis in a population of commercial dairy cows. They found that cows which retained the fetal membranes were at a higher risk (relative risk = 1.5) of developing mild mastitis, and at a much higher risk (relative risk = 5.4) of developing severe mastitis with systemic manifestation than were cows not retaining the membranes. A further finding was that longer duration of placental retention was associated with greater likelihood of mastitis. In a follow-up study in a hospital-based population, this group confirmed these results. These authors speculate that the relationship between retained placenta and mastitis is mediated by deficient peripartal peripheral neutrophil phagocytic activity.

In 1984 Gunnink proposed that deficient neutrophil activity was a factor in the pathogenesis of RFM in cattle. He showed that circulating leukocytes from cows with RFM showed diminished chemotactic responses to cotyledon suspensions in vitro. He further demonstrated that this impaired chemotactic response existed before parturition and that it persisted at least 10 days into the post-partum period. Heuwieser and Grunert have also reported impaired neutrophil migration in cows which retained fetal membranes.

We therefore designed experiments to determine whether periparturient neutrophil function was influenced by parity of the cow or by RFM as part of a project aimed at illuminating pathophysiological factors with epidemiological observations.
Materials and Methods

In Experiment 1, 45 consecutively calving Holstein cows and heifers from a single dairy herd were included. These cows were allocated to parity groups: parity 1-3 and parity 4+. Blood samples were obtained from each animal during the week prior to anticipated parturition, within 4 days postpartum, at 3 weeks postpartum and at 6 weeks postpartum. At each sampling time complete blood counts were performed. Neutrophils were separated from the blood by differential centrifugation and hypotonic lysis of contaminating erythrocytes. Recovered cells were washed and resuspended in Hank’s buffered salt solution for functional analysis. Superoxide anion production was determined at 38 °C as the superoxide dismutase-inhibitable reduction of ferricytochrome-c after stimulation of neutrophils with phorbol myristate acetate (PMA) as described and modified. Neutrophil shape change (deformability, polarization) was determined by exposing a suspension of cells to a subaggregating dose of zymosan activated bovine plasma (ZAP) as described. Cells were assessed for shape change at 0, 30, 60 and 120 seconds after exposure to a 1:500 dilution of ZAP. A single batch of ZAP was used for the entire experiment. Cells with a perceived shape change were recorded as reactive. After counting 200 cells, the proportion of reacted cells was recorded as a percentage.

In Experiment 2, 8 cows which experienced spontaneous RFM after delivery of a single, live calf were identified in a single commercial dairy herd. For this study, RFM was defined as retention of fetal membranes for longer than 48 hours postpartum. For each cow so identified, a matched herdmate which had calved within 48 hours before or after the cow with RFM was chosen as a control. Blood samples were obtained from these animals at 3-5 days postpartum, 3 weeks postpartum and 6 weeks postpartum. Neutrophil function tests were the same as those used in Experiment 1.

Results

In both experiments neutrophil numbers were increased immediately postpartum. They declined over the next 3 weeks in both parity groups in Experiment 1, and in the normal, control cows in Experiment 2. In cows with RFM, they became progressively more elevated during the postpartum period.

In Experiment 1, all cows showed a significant decline in neutrophil function as measured by superoxide anion generation and stimulus-induced shape change from the prepuratum sampling to the first postpartum sampling period. At this time, there was a significant difference between parity groups: cows of advanced parity (4 or higher) had significantly lower neutrophil activity than cows of parity 1-3. Function parameters increased for both groups from parturition to 3 weeks postpartum, and then stabilized.

In Experiment 2, neutrophils from cows with RFM produced significantly less superoxide anion than control cows at the immediate postpartum sampling period and at 6 weeks postpartum. Neutrophils from cows with RFM were also significantly less reactive in the shape change assay than cells from control cows at the immediate postpartum sampling period.

Discussion

Periparturient impairment of neutrophil function is likely to contribute to the observed increase in susceptibility to infectious conditions in dairy cows at this time. The greater severity of impairment in cows of advanced parity and those with RFM is compatible with epidemiological evidence that cows in these groups have increased susceptibility to some infections.

Resume

Il est bien établi que la fonction neutrophilique chez la vache péri-parturiente est diminuée. C’est aussi la période pendant laquelle le tractus génital de la vache...
est la plus susceptible aux complications infectueuses. Le degré de l'inhibition (la diminution ??) de la fonction neutrophilique peut être lié à l'incidence de nouvelles infections bactériennes pendant cette période. La plupart des dérangements reproductifs chez ces vaches sont reliés les uns des autres, et il est logique de penser qu'il y a des facteurs sous-jacents qui predisposent les vaches à ces complications; il est alors possible qu'un tel facteur soit le degré d'atténuation de fonction neutrophilique de la vache periparturiente.

Du point de vue épidémologique, on identifie plusieurs facteurs de risque qui predisposent des vaches aux complications post-partum. On fit une série d'expériences pour évaluer si les facteurs de risques identifiés pour ces dérangements furent aussi associés à l'inhibition de fonction neutrophilique.

On observa que les vaches assujetties aux retentions placentaires pour plus de 24 heures avaient une diminution marquée de la fonction neutrophilique par rapport aux vaches de contrôle. La sévérité de cette diminution fut plus importante en vaches presque à terme que chez les vaches dont la gestation était moins avancée. Des effets saisonniers et de troupeau furent aussi identifiés. A présents, les donner a notre disposition soutiennent le concept que la diminution de la fonction neutrophilique d'une vache à terme est un facteur principal qui influence la susceptibility des vaches aux infections bactériennes. Ceci mine à des changements dans la gestion pour limiter ou empêcher la diminution de la fonction du neutrophile. En conséquence, il est possible que cela puisse réduire la susceptibility des vaches laitières aux infections pendant cette période.

Sumario

Se sabe que la función neutrófila en vacas sufre un deterioro durante el periodo periparturiento. Este es también el periodo de la vida reproductiva de la vaca durante el cual es mas susceptible a complicaciones infecciosas. El grado de depresión en función neutrófila en el periodo periparturiento puede estar relacionado con la incidencia de infecciones bacterianas nuevas durante este periodo. La mayoría de los desórdenes reproductivos de la vaca periparturienta están interrelacionados y es lógico asumir que hay factores comunes básicos que predisponen a las vacas a éstas complicaciones; un factor tal es posiblemente la extensión de depresión periparturienta en función neutrófila.

Epidemiologicamente, varios factores riesgo que predisponen a la vaca a complicaciones de posparto han sido identificados. Una serie de estudios fueron conducidos para determinar si los factores riesgo identificados para desordenes de posparto estaban también relacionados con un mayor grado de deterioro en función neutrófila periparturienta.

Vacas que retuvieron las membranas fetales más de 24 horas después del parto tuvieron un deterioro más profundo en función neutrófila que las vacas del grupo control. La severidad del deterioro en función neutrófila durante el periodo periparto fue mayor en vacas de avanzada paridad que en vacas más jovenes. Efectos de estación de año y de manada también fueron identificados.

Los datos actuales disponibles apoyan el concepto de que un deterioro en la función neutrófila durante el periodo periparturiento es uno de los factores que influyen la susceptibility de vacas a infecciones bacterianas. Un mayor entendimiento de los factores que determinan diferencias de manada y de estación de año promete conducir a intervenciones de manejo para limitar o prevenir esta depresión en función neutrófila. En turno, esto posiblemente aminore la susceptibility de vacas lecheras a infecciones durante este periodo.

References