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[1] 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.[1]

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.[2] A separate study[3] 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[2] and mastitis.[4,5] Even when controlling for the effects of specific, diagnosed diseases, advancing parity was associated with reduced reproductive efficiency.[6] 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[2,3,7] ketosis[3], mastitis[2,4,5] and even subsequent abortion in the following pregnancy.[2] Schukken, Erb and Smith[5] 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.[4] 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.[8-10] He showed that circulating leukocytes from cows with RFM showed diminished chemotactic responses to cotyledon suspensions in vitro.[8] He further demonstrated that this impaired chemotactic response existed before parturition[9] and that it persisted at least 10 days into the post-partum period.[10] Heuwieser and Grunert[11] 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[16], 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.[12] 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[13] and modified.[14] 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.[15] 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[17], 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 progressivley 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 prepartum 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

Peirparturient 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 etable que la fonction neutrophilique chez la vache peri-parturiente est diminuee. C'est aussie la periode pendant laquelle le tractus genital de la vache

est la plus susceptible aux complications infectueuses. Le degre de l'inhibition (la diminution ??) de la fonciton neutrophilique pent etre lie a l'incidence de norwelles infections bacteriennes pendant cette periode. La plupart de4s derangements reproductifs chez ces faches sont relies les uns des autres, et il est logique de penser qu' el y a des facteurs sous-jacents qu predisposent les vaches a ces complications; il est alors possible qu' un tel facteur soit le degre d'attenuation de fonction neutrophilique de la vache periparturiente

Du point de vie epidemologique, on identifia plusieurs facteurs de risque qui predisposent des vaches aux complications post-partum. On fit une serie d'experiences pour evaluer si les facteurs de risques identifies pour ces derangements furent aussi associes a l'inhibition de fonction neutrophilique.

On observa que les vaches assujeties aux retentions placentaires pour plus de 24 heures avaient une diminution marquie de la fonciton neutrophilique par rapport aux vaches de controle. La severite de cette deminuation fut plus imkportante en vaches presqu' a terme que chez les vaches dont la gesztation etait moins avancee. Des effets saisonsiers et de tronpeau furent aussi identifies. A preszent, les donneer a notre disposition soutiennent le concept que la diminution de la fonction neutrophilique d'une vache a terme est un facteur principal qui influence la susceptibilite des vaches aux infections bacteriennes. Ceci mine a des changements dans la gestion pour limiter ou empecher la diminution de la fonction du neutrophile. En consequence, il est possible que cela puisse reduire la suscpetibilite des vaches laitiers aux infections pendant cette periode.

Sumario

Se sabe que la función neutrófila en vacas sufre un deterioro durante el periodo periparturiento. Este es también el período de la vida reproductiva de la vaca durante el cual es mas susceptible a complicaciones infecciosas. El grado de depresión en función neutrôfila en el período periparturiento puede estar relacionado con la incidencia de infecciones bacterianas nuevas durante este periodo. La mayoría de los desórdenes reproductivos de la vaca periparturienta estan 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 tambien relacionados con un mayor grado de deterioro en funcion neutrofila periparturienta.

Vacas que retuvieron las membranas fetales más de 24 horas después del parto tuvieron un deterioro màs profundo en función neutrófila que las vacas del grupo control. La severidad del detrerioro en función neutrófila durante el período periparto fue mayor en vacas de avanzada paridad que en vacas mas jovenes. Efectos de estacion 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 período periparturiento es uno de los factores que influyen la susceptibilidad de vacas a infecciones bacterianas. Un mayor entendimiento de los factores que determinan diferencias de manada y de estacion de año promete conducir a intervenciones de manejo para limitar o prevenir esta depresion en función neutrófila. En turno, esto posiblemente aminore la susceptibilidad de vacas lecheras a infecciones durante éste periodo.

References

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