Risk factors for umbilical hernia in Holstein heifers during the first two months after birth

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Objective—To determine risk factors associated with identification of an umbilical hernia during the first 2 months after birth in Holstein heifers.

Design—Case-control study.

Animals—322 Holstein heifers born in a single herd (45 with an umbilical hernia and 277 without).

Procedure—Risk factors that were examined included sire, whether the dam had a history of umbilical hernia, milk yield, duration of gestation, whether the dam had a history of dystocia, whether the heifer had a twin, birth weight, total serum protein concentration, and whether the heifer had an umbilical infection. Logistic regression was used to analyze risk factors.

Results—Heifers born to sires with ≥ 3 progeny with an umbilical hernia were 2.31 times as likely to develop an umbilical hernia as were heifers born to sires with ≤ 2 progeny with an umbilical hernia. Heifers with umbilical infection were 5.65 times as likely to develop an umbilical hernia as were heifers without umbilical infection.

Conclusions and Clinical Relevance—Sire and umbilical infection were associated with risk of an umbilical hernia during the first 2 months of life in Holstein heifers. Attributable proportion analysis indicated that the frequency of umbilical hernias in Holstein heifers with umbilical infection would have been reduced by 82% if umbilical infection had been prevented. (*J Am Vet Med Assoc* 2004;224:1487–1490)

Umbilical hernias are commonly identified in dairy heifers.[1,2] In a study[3] of 18 commercial dairy herds in New York, for instance, 62 of 410 (15%) heifers were reported to have had umbilical hernias during the first 3 months of life. Economic costs of umbilical hernias include the costs of medical and surgical treatment and the loss in value for breeding animals.

It is generally accepted that umbilical hernias may be inherited in a dominant (ie, a grandsire, sire, and son will all produce the condition when mated to unrelated females) or recessive (ie, association of calves with umbilical hernias to a particular sire is difficult) fashion.[4-6] In addition, a study[7] at 10 veterinary teaching hospitals in the United States and Canada found that the risk of umbilical hernia among Holstein cattle was twice that for cattle of other breeds (Angus, Ayrshire, Brown Swiss, Charolais, Guernsey, Hereford, Jersey, and Shorthorn). On the other hand, factors other than genetics also appear to play a role in the development of umbilical hernias. For instance, although a relationship between umbilical hernias and umbilical infection has not been definitively established, clinical observations by veterinarians suggest that umbilical infection may lead to the development of an umbilical hernia by slowing closure of the umbilicus.[1,2]

The identification of risk factors for umbilical hernia may assist efforts to reduce their incidence. To our knowledge, however, risk factors associated with the development of umbilical hernias among Holstein heifers have not been investigated. The purpose of the study reported here was to identify risk factors associated with identification of an umbilical hernia during the first 2 months after birth in Holstein heifers.

Materials and Methods

Study design—The study was designed as a case-control study to compare the frequency of risk factors among heifers with or without an umbilical hernia during the first 2 months of life. Heifers born between January 2001 and December 2002 at the University of Florida, Institute of Food and Agricultural Services, Dairy Research Unit herd were used in the study. The herd consisted of approximately 500 Holstein cows with a rolling herd average milk production of approximately 20,000 lb/y. The herd was located in Florida and had a history of having a high number of heifers with umbilical hernias. Cows in the herd were artificially inseminated by trained farm personnel following estrus synchronization. Heifer calves were individually housed in wire hutches on sand bedding under a common roof. Heifers with signs of illness or poor performance were examined by the attending veterinarian. In addition, all heifers were examined by the attending veterinarian 2 months after birth, before being moved into group pens. Heifers born to cows that had not been born on the farm and heifers for which medical records were incomplete were excluded from the study. For cows that produced 2 heifers during the study period, only the more recently born heifer was included in the study. Bull calves were not available for inclusion in the study, as they were sold in the first few days of life and were not examined by a veterinarian.

Selection of cases and controls—Case heifers consisted of heifers born during the study period in which an umbilical hernia was identified during the first 2 months after birth. A preliminary diagnosis of umbilical herniation was made by farm personnel and confirmed by the attending veterinarian. Heifers with an umbilical hernia had a palpable opening > 1.0 cm in diameter in the umbilical area.[3,8] Control heifers included all heifers born during the study period in which an umbilical hernia was not identified during the first 2 months after birth.

Data collection—Data gathered for each heifer included birth date, birth weight, whether an umbilical hernia was identified (yes vs no), date of diagnosis of umbilical hernia, whether umbilical infection was identified (ie, a palpably enlarged umbilicus, signs of pain on palpation of the umbilicus, or both) before or at the same time an umbilical hernia was identified, date of diagnosis of umbilical infection, sire, and total serum protein concentration within the first 2 to 8 days after birth. Total serum protein concentrations were determined by a trained animal health technician with a refractometer,[a] as described.[9] Data gathered for each dam included calving season (summer [May through September] vs winter [October through April]), lactation number (1 vs ≥

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2), dystocia (yes vs no), and twins (yes vs no). From Dairy Herd Improvement Association records, information on the 305-day mature equivalent milk yield was collected at the end of the lactation period or when the cow left the herd.

Statistical analyses—Logistic regression was used to model the odds of a heifer being identified as having an umbilical hernia during the first 2 months after birth as a function of risk factors evaluated in the study. Univariable logistic regression was used for initial screening of potential risk factors. Continuous variables (duration of gestation, milk yield, and birth weight) were dichotomized as less than or greater than the median value. Total serum protein concentration was classified as inadequate (4.0 to 5.0 g/dL) or adequate (≥ 5.1 g/dL). Factors for which the *P* value in univariable analyses was ≤ 0.2 were included in multivariable logistic regression analysis. A backward-stepping approach was used to identify multivariable models with the *P* value for retention being ≤ 0.10. A model with a hierarchical structure was specified by adding terms for biologically plausible interactions between independent variables. Goodness-of-fit was determined by calculating the Hosmer-Lemeshow goodness-of-fit χ^2 statistic. In the final model, adjusted **odds ratios (OR)** and 95% **confidence intervals (CI)** were reported. In this study, the OR was used as an epidemiologic measure of association between a factor (eg, umbilical infection) and risk of umbilical hernia. Thus, if a particular factor was not associated with risk of umbilical hernia, the OR was 1. The greater the departure of the OR from 1 (either larger or smaller), the stronger the association between the factor and risk of umbilical hernia. The attributable proportion ([OR – 1]/OR) was calculated for the risk factor "umbilical infection" and interpreted to represent the proportion of heifers with umbilical infection that developed an umbilical hernia because of infection. For final analyses, values of $P \leq 0.05$ were considered significant.

Results

Forty-five case and 277 control heifers were included in the study. Median age of case heifers at the time an umbilical hernia was identified was 3 weeks. All heifers were produced by 1 of 82 sires, except that the sire of 3 control heifers was not recorded in the herd records. Overall, 7 sires had more than 10 progeny each (range, 11 to 22) during the study period.

In univariable analyses, having a dam with a his-

Table 1—Results of univariable logistic regression analysis of the risk of identification of an umbilical hernia during the first 2 months after birth in Holstein heifers

Variable	No. of cases (%)	No. of controls (%)	OR	95% CI	*P* value
Sire with ≥ 2 progeny with an umbilical hernia					< 0.01
No	20 (44)	185 (67)	Reference	NA	
Yes	25 (56)	89 (33)	2.60	1.37–4.93	
Sire with ≥ 3 progeny with an umbilical hernia					0.04
No	34 (76)	239 (87)	Reference	NA	
Yes	11 (24)	35 (13)	2.21	1.03–4.75	
Dam with a history of umbilical hernia					0.95
No	29 (91)	171 (91)	Reference	NA	
Yes	3 (9)	17 (9)	1.04	0.29–3.78	
Lactation No.					0.53
1	13 (29)	93 (34)	Reference	NA	
≥ 2	32 (71)	184 (66)	1.24	0.62–2.48	
Milk yield (lb)					0.42
8,490–22,600	20 (44)	134 (51)	Reference	NA	
22,601–38,346	25 (56)	129 (49)	1.30	0.69–2.45	
Duration of gestation (d)					0.94
256–274	23 (42)	135 (51)	Reference	NA	
275–292	22 (48)	132 (49)	0.98	0.52–1.84	
Calving season					0.24
Winter	23 (51)	167 (60)	Reference	NA	
Summer	22 (49)	110 (40)	1.45	0.77–2.73	
Dystocia					0.98
No	33 (73)	202 (73)	Reference	NA	
Yes	12 (27)	74 (27)	0.99	0.49–2.02	
Twins					0.41
No	42 (93)	266 (96)	Reference	NA	
Yes	3 (7)	11 (4)	1.73	0.46–6.44	
Birth weight (kg)					0.43
16–35	26 (59)	137 (59)	Reference	NA	
> 35–54	18 (41)	123 (41)	0.77	0.40–1.47	
Total serum protein (g/dL)					0.19
4.0–5.0	2 (5)	28 (12)	Reference	NA	
5.1–7.9	39 (95)	206 (88)	2.65	0.61–11.15	
Umbilical infection					< 0.01
No	36 (76)	265 (96)	Reference	NA	
Yes	9 (24)	12 (4)	5.52	2.18–14.01	
Umbilical infection*					0.04
No	36 (88)	265 (96)	Reference	NA	
Yes	5 (12)	12 (4)	3.07	1.02–9.20	

OR = Odds ratio. CI = Confidence interval. NA = Not applicable.
*Four heifers with concurrent umbilical hernia and umbilical infection were not included.

Table 2—Results of multivariable logistic regression analysis of the risk of identification of an umbilical hernia during the first 2 months after birth in Holstein heifers

	Model 1			Model 2*		
Variable	**OR**	**95% CI**	***P* value**	**OR**	**95% CI**	***P* value**
Sire with ≥ 3 progeny with an umbilical hernia			0.03			0.04
No	1.00	Reference		1.00	Reference	
Yes	2.31	1.01–5.08		2.27	1.02–5.06	
Umbilical infection			< 0.01			0.04
No	1.00	Reference		1.00	Reference	
Yes	5.65	2.20–14.51		3.17	1.04–9.61	

See Table 1 for key.

tory of an umbilical hernia, milk yield, duration of gestation, dystocia, twins, calf birth weight, and total serum protein concentration were not significantly ($P \geq 0.25$) associated with identification of an umbilical hernia (**Table 1**). Heifers born to sires with ≥ 3 progeny with umbilical hernias during the study period were 2.21 times as likely to have an umbilical hernia as were heifers born to sires with ≤ 2 progeny with umbilical hernias. Heifers with a history of umbilical infection were 5.52 times as likely to have an umbilical hernia as were heifers without a history of umbilical infection.

In multivariable analyses, variables for sire with ≥ 3 progeny with an umbilical hernia and a history of umbilical infection were retained in the final model (**Table 2**). Addition of 2-way interaction terms did not contribute to the final model for risk of umbilical hernia, and these terms were removed from the model. Heifers born to sires with ≥ 3 progeny with an umbilical hernia were 2.31 times as likely to have an umbilical hernia as were heifers born to sires with ≤ 2 progeny with an umbilical hernia, and heifers with a history of umbilical infection were 5.65 times as likely to have an umbilical hernia as were heifers without a history of umbilical infection. Findings were similar when the 4 heifers with concurrent umbilical infection and umbilical hernia were removed from the analysis. The attributable proportion of heifers with umbilical infection that developed an umbilical hernia because of that infection was 0.82 when all heifers were considered or 0.68 when heifers with concurrent umbilical infection and umbilical hernia were excluded.

Discussion

Results of the present study suggest that sire and umbilical infection are important risk factors for umbilical hernia during the first 2 months after birth in Holstein heifers. It is possible that heifers that had small hernias (eg, < 1.0 cm in diameter) that healed before examination may have been misclassified as control heifers in the present study. If so, then the reported ORs may have been underestimated.

Clinical observations by veterinarians have suggested that umbilical hernias may develop in heifers when umbilical infection prevents or delays normal closure of the umbilicus.[1,2] Thus, for umbilical infection to be considered a cause of umbilical hernia, it must develop prior to development of the hernia. For this reason, we repeated logistic regression analyses in the present study, excluding the 4 of 9 heifers with umbilical hernia and umbilical infection that had these conditions concurrently. Results were consistent with results obtained when all heifers were included, supporting the conclusion that sire and umbilical infection were associated with the risk of umbilical hernia among Holstein heifers during the first 2 months after birth.

In the present study, after adjusting for the effects of umbilical infection, heifers born to 3 sires with ≥ 3 progeny with an umbilical hernia were 2.31 times as likely to have an umbilical hernia as were heifers born to 79 sires with ≤ 2 progeny with an umbilical hernia. The 3 sires with ≥ 3 progeny with an umbilical hernia had each produced > 10 progeny, and 11 of 46 (24%) heifers produced by these sires had an umbilical hernia. In contrast, there were 4 additional sires that each produced > 10 progeny, but only 5 of 61 (8%) heifers produced by these sires had an umbilical hernia. The high frequency of umbilical hernia among heifers born to 3 specific sires confirms that they had a genetic influence on the risk of umbilical hernia. Similarly, a recent study[10] in Germany of the association between sire and incidence of congenital umbilical hernia among 53,105 German Fleckvieh calves for sale at 77 livestock markets found that the incidence of congenital umbilical hernia in 76 progeny groups (ie, calves produced by sires that had produced > 100 calves each) varied from 0.1% to 7.1%. Other risk factors with a significant influence on incidence of congenital umbilical hernias included sex of the calf (male), birth type (multiple), age of the calf at the time of examination (< 5 weeks old), market place, and season (January to June); calves with umbilical infection were excluded from the study. Results from this previous study,[10] however, are difficult to compare with results of the present study because of differences in study design, exposure and outcome measures, number of animals, breed, and statistical methods used.

Heifers with umbilical infection were 5.65 times as likely to have an umbilical hernia in the present study as were heifers without umbilical infection. Clinical observations by veterinarians have suggested that umbilical hernias in calves are associated with infections of the umbilical opening, which prevent normal closure.[1,2] However, the relationship between umbilical infection and umbilical hernia in dairy heifers has not been well established. In a New York study,[3] 8 of 62 (13%) heifers with hernias also had umbilical infection before or at the same time and the authors suggested that infection may be an important risk factor for development of hernias. However, the frequency of

infection in heifers without hernias was ignored in that study. A visual examination of results in that study revealed that 50 of 348 (14%) heifers without hernias also had umbilical infection. It is possible that congenital umbilical hernias may have masked or overridden the role of umbilical infection as a risk factor for umbilical hernia in heifers in that study. In the present study, attributable proportion analysis indicated that the frequency of umbilical hernias in Holstein heifers with umbilical infection would be reduced by 82% or 68% if umbilical infection had been prevented.

[a]AO Scientific Instruments, Buffalo, NY.

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Correction: Book Reviews: *For Your Library*

In "Book Reviews: *For Your Library*" published March 15, 2004 (*J Am Vet Med Assoc 2004*;224:852–859), the review of "*The Equid Ethogram: A Practical Field Guide to Horse Behavior*" contained errors. The corrected book review is published here in its entirety.

The Equid Ethogram: A Practical Field Guide to Horse Behavior

Reviewed by Catherine Ulibarri, PhD

In *The Equid Ethogram: A Practical Field Guide to Horse Behavior*, Dr. McDonnell has skillfully designed and written an extensive ethogram that can be used by virtually all observers of equine behavior. The descriptions of behavior are clear and concise, and they are strengthened by the use of excellent photographs as well as references listed for each behavior. Some of the color pages are difficult to read, and I suspect that readers who have problems with color-blindness would have considerable difficulty. The book seems fairly priced. Although I disagreed with some of the interpretations given to some of the behaviors, overall this is an excellent ethogram that can provide good standardization for the observation of behavior in equids. As such, it should be required reading for ethologists, even those not particularly interested in equine behavior, as an example of how to characterize a complex ethogram.—*By Sue McDonnell. 384 pages; illustrated. Eclipse Press, 1736 Alexandria Dr, Lexington, KY 40504. ISBN 1-58150-090-4. 2002. Price $39.95.*