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# Hernia and Its Heredity

\* *Grant M. Carman, B.S.A., M.S.*

**H**ERNIA IS THE PROTRUSION of an organ, or part of an organ or other structure, through the wall of the cavity normally containing it. While the term applies to other regions of the body, in farm animals it refers to defects in the abdominal wall, unless otherwise qualified, and is the protrusion of a viscus, or viscera, through a natural or abnormal opening in the abdominal wall over which the skin remains intact. Rupture is its every-day synonym, and perhaps is a more widely used term than the more correct hernia.

Man has been afflicted with hernia since the first recordings of written history. Celsus, who lived in the first century A.D., wrote of the first permanent operation for its relief. The crude surgery of medieval times included the removal of the testicle — Warwick.<sup>12</sup> Youatt<sup>15</sup> made the first known reference to hernia in swine. Since that time it has been recorded in all species of domestic animals, with man himself perhaps the greatest sufferer.

Warwick reported an incidence of 2.28 percent hernia in male pigs studied in 1923 and 1924, 0.60 percent being umbilical, 1.68 percent scrotal. Approximately one percent of the female pigs were herniated, the greater proportion being umbilical. The incidence in the other species of domestic animals cannot

be estimated accurately as extensive surveys of veterinary clinical records have not been made. Umbilical hernia in the equine and bovine constitute more than half of all cases in those species, followed by scrotal and ventral, or abdominally induced hernias in that order, according to Farquharson.<sup>2</sup>

## Classification

In livestock, in general, there are three types of hernia: inguinal, scrotal and umbilical. In an inguinal hernia the vaginal canal serves as the hernial sac, and one or more loops of the intestine or other abdominal organs pass through, or alongside, the canal carrying the spermatic cord. In scrotal hernia the scrotum is the hernial sac, and in an umbilical hernia the umbilicus or navel opening, is the hernial ring.

In the unborn animal the testicle is located in the abdominal cavity just posterior to the kidney. During the latter stages of foetal development the testis descends through the inguinal ring into the inguinal canal, and thence into the scrotum. It carries with it the ductus deferens, blood and lymph vessels, the external cremaster muscle, and a fold of the peritoneum to act as a lining for the scrotum. After the testes have reached the scrotum, the inguinal ring increases very little in size and as the testes grow they cannot be drawn back into the abdominal cavity. The exceptions to this rule are some of the rodents that can retract the testes at will, and those animals, such as the deer,

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that have the testes descended only during the breeding season. The inguinal canal, on the other hand, continues to grow in size, and if the vaginal ring does increase in size, part of the abdominal viscera can easily pass down the canal, or into the scrotum, constituting a hernia. A scrotal hernia, then, is an inguinal hernia in which the organ has passed beyond the inguinal canal into the scrotum.

An umbilical, or navel hernia, is one in which part of the abdominal viscera passes through the umbilical, or navel, ring. This ring forms the opening for the umbilical cord during foetal life, and after birth normally closes. If this closure is not accomplished, the skin is not strong enough to support the pressure of the abdominal viscera and a hernia results.

Most types of hernia can be reduced surgically and, be it in livestock or man, recovery is generally well accomplished. It is not the purpose of this article to discuss such treatment, as any text on the subject will make familiar to the reader the various and sundry surgical techniques available for hernia reduction.

### Inheritance

Fisher<sup>3</sup> and Ghigi<sup>5</sup> spoke of a type of cerebral hernia in fowl that is associated with the crest. Both agreed that it is caused by a single gene, Fisher believing it to be without dominance in the homozygous condition, the heterozygote being crested, and the gene acting as a delayed lethal, while Ghigi believed it to be a recessive. Many modifying genes are apparently present, because such breeds as the Houdan and Silkie do not evidence the expected one-quarter death rate unless they are crossed to a non-crested breed, and these hybrids are then mated and their progeny studied.

Burrows<sup>1</sup> recorded the occurrence of perineal hernia in the C-57 black strain of laboratory mouse. The hernial sacs contained a part of a much distended seminal vesicle. No observations were made as to its mode of inheritance, but it was noted that all affected individuals became sterile at an abnormally early age.

Moore and Schaible<sup>9</sup> reported an in-

cidence of 414 rats in 1058 with umbilical hernia. By selective inbreeding they were able to increase the percentage of hernia to approximately 70 percent. By similar means the size of the hernia was also increased. The authors noted a significant deficiency of males in the herniated lines, and postulated a multiple factor inheritance, not sex limited.

### Heredity In Swine

Perhaps more study has been placed on the heredity and treatment of hernia in swine than in all other species of livestock combined. Certainly the average farmer has more often seen, and experienced loss from, hernia in his pigs than in his other farm animals. Warwick<sup>12</sup> conducted the classical experiment on the inheritance of hernia in swine. At that time he estimated the economic loss to the farmer was a dollar per herniated animal and he calculated 417,000 head would be herniated in each year's production. He selected as his breeding stock herniated animals from the University of Wisconsin Duroc herd, and bred these animals for several generations. The results of his experiments are as follows:

**Occurrence of Scrotal Hernia in Warwick's Experiment.**

Generation	Total Males	Herniated Males	Percent Herniated
1	69	11	14
2	92	39	42
3	69	31	44
4	70	31	44
5	57	27	47
6	11	10	90
7	5	2	40

The increase in the percentage of herniated males as a result of selecting only herniated boars shows definitely that the defect is hereditary. Using the data above, and the fact that most of the females used had a close relationship to the herniated boars, Warwick presented the hypothesis that scrotal hernia depends on the presence of two pairs of recessive genes in the homozygous condition. Johnson<sup>6</sup> presents good evidence that more than the

two-factor hypothesis is needed to explain the inheritance of scrotal hernia. He points out that selection for hernia gave a frequency of herniated males that asymptotically approached approximately 50 percent, whereas, if two pairs of genes controlled the condition a 100 percent incidence would be expected. It is also noted that the gene frequency for such an explanation would have to be about 0.45 for both genes, which is much too high an incidence to be expected. Johnson instead postulates a single gene theory with approximately 50 percent penetrance.

Wreidt<sup>14</sup> had an apparently normal Large White boar, Syver Kalnes 81, that had 25 umbilically herniated progeny in a total of 73 pigs. There had never been any evidence of this condition in the previous progeny of any of the sows, so the anomaly was definitely inherited from this single sire. The author explained the character as an incomplete dominant with low penetrance.

Magee<sup>8</sup> conducted an investigation into the incidence of hernia in the Iowa State College experimental herd. He found that there was a definite maternal effect towards hernia in those swine studied, its heritability being approximately 15 percent. He also pointed out that here is a possible negative correlation between scrotal hernia and cryptorchidism. If such is the case, selection against one might be selection for the other. He concluded that scrotal hernia is a threshold character of low heritability, his estimate of heritability for the character being approximately ten percent.

#### **Heredity In Other Species**

Frank<sup>4</sup> stated that scrotal hernia is a rather frequent occurrence in aged beef bulls, but asserted that there seemed to be little tendency for the weakness to be hereditary. Warren and Atkeson<sup>11</sup> recorded the presence of umbilical hernia in Holstein-Friesian cattle, all cases tracing to one sire. The hernias appeared in calves between the ages of eight and twenty days, and tended to disappear at from ten weeks to seven months of age. Only one animal retained this condition past seven months of age, and he evi-

dened the defect still at six years of age. The authors believed that the character was a simple dominant, sex limited in nature, and as such was of relative unimportance to the cattle industry.

Sigler<sup>10</sup> stated that scrotal hernia is frequent in stallions, particularly following the castration of older horses. He also believed it to be common in the equine newborn, but asserted that it disappears as the foal develops and becomes stronger. Kolos<sup>7</sup> recorded that abdominal induced hernia is the most frequent type found in Russian army horses, and described an operating procedure for successful surgical repair.

From the legion of case histories present on hernia in humans, an article by West<sup>13</sup> was elected as perhaps the most illustrative of its heredity and occurrence. He recorded its presence in two families, one labourers, and the other following a sedentary occupation. The occupational hazards towards inducing the condition proved negligible.

The concensus of opinion of the writer seems to indicate that hernia in humans is due to a simple dominant gene with nearly complete penetrance in males, less complete in females.

It is apparent that the anomaly of hernia is hereditary, but definitely possesses a particular inheritance within species. In fowl it is an incomplete dominant with many modifying factors. In rodents the inheritance is more obscure, but from the evidence presented is probably a character of multiple factor inheritance, not sex limited.

Wreidt<sup>14</sup> undoubtedly has a case of a single dominant gene with low penetrance in his Large White pigs. Warwick postulated its inheritance as being that of two recessive factors in the homozygous condition, but Johnson presents good evidence that it is instead a single, recessive gene with approximately 50 percent expression, and being sex-limited in nature.

With the exception of its effect on a very small number of aged beef bulls, and in some stallions following castration, hernia in the bovine and equine appears to have little or no economics importance.

Because it is a character of incomplete penetrance, its eradication is practically impossible, but the incidence can probably be decreased in the herds where outbreeding is practiced by discarding all herniated males, and eliminating as far as possible all breeding females that have produced herniated offspring. This is particularly important in light of Magee's finding that hernia is so strongly maternally affected. Thus, corrective methods of breeding and selection may reduce the incidence of hernia to a minimum, and careful attention to surgical methods available may repair those that do occur until their market value may be realized.

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