HERNIA IN *NECTURUS MACULOSUS**

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INTRODUCTION

Man, because of his upright position and the fact that he is in possession of certain anatomical weak spots in the abdominal wall, such as the inguinal canals and umbilicus, is especially liable to hernia or rupture conditions. Heavy labor, overstrenuous games, bronchial diseases, and all activities tending to promote an increase in abdominal pressure through the descent of the diaphragm and the contraction of the abdominal muscles—these operate in the formation of some hernias. Others are congenital. Oftentimes they are not a great hindrance to normal activities. Occasionally serious complications arise as a result of stricture.

In higher forms below man, especially the dog, cases of inguinal hernia have been reported. These are referred to as rare. Quadrupeds have the advantage of a more equal distribution of the weight of the abdominal organs upon the abdominal wall, and so, less weight upon the weak inguinal region.

There is a dearth of recorded cases of hernia in animals below the mammals. It would seem that in a group like the amphibia, which do not possess the anatomical weaknesses which make the higher forms susceptible to hernia, this condition would be infrequent. Observations on Necturi specimens used in the laboratories of the department of Zoölogy are tending to the conclusion that hernia is fairly common, certainly in this species. Students were cautioned to watch for these abnormalities. To date, hernias have been reported which involve the lungs, liver, intestine, stomach, and oviduct. All stages from partial to complete hernia are represented in the series. A statistical study over a number of school years should prove interesting.

This paper is a description of three hernial conditions found in a specimen of *Necturus maculosus,* and reported by a student, E. Nebeck.

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Description

Examination of the specimen disclosed a hernia of the liver and two separate areas of the intestines. The formalin used for preservation of the animals so hardened the tissues that it was possible to make perfect casts of the hernial sacs, and these represented the extruded portions of the organs which could be referred to their respective sacs in the abdominal wall. Only one hernia remained unreduced on discovery, the others having been disturbed through laboratory dissection, but from the casts their original condition was evident.

An oval area of the liver (about 2 centimeters by 1 centimeter) just anterior to the gall bladder, extruded through the abdomnial wall. The peritoneum, transversus and internal oblique muscles were involved in the order named. The rim of the hernial sac showed a thickening of the peritoneum, and also described the limit or remnant of this lining in the area involved. The internal oblique muscle, for the most part, formed the floor of the sac, although it was separated to the extent of 2 millimeters to receive a very restricted portion of the protruding liver. Through this separation, the fibres of the external oblique muscle were visible and demonstrated the furthermost progress of this hernia. The liver, through pressure, had apparently caused the atrophy of the fibres of the transversus muscle which are normally found external to the peritoneum. They were visible only as a roughened mass near the periphery of the sacculation. This condition, and that of the peritoneum, suggests that the rupture had been present for a long time. The perforation in the internal oblique muscle, on the other hand, suggests a more recent rupture. No atrophy through pressure is apparent. Dissections of the abdominal wall beyond the site of the hernia showed it to be otherwise normal.

The second hernia involved the intestine (about mid-way along the tract) and the abdominal wall on the right side at a point near the lateral edge of the rectus muscle. As in the first case, peritoneum and transversus muscle were perforated, but the internal oblique muscle alone formed the floor of the hernial sac. The sac permitted the displacement of a very small, evaginated area of the gut, which measured 2 by 4 millimeters in its greatest transverse diameters. The mass was constricted at the point of evagination so that it gave the appearance of a minute mushroom. Referring again to the hernial sac itself, the transversus muscle was seen to be separated definitely along the direction of its fibres, and did not present the frayed and irregular appearance described for the liver hernia. In general, the more limited nature, and the condition of the layers, suggest a fairly recent origin for this

hernia. Again, the site of the rupture (the lateral border of the rectus muscle) is a weak spot because the transversus muscle is limited in fibres here and ends in the thin peritoneum. Another mechanical factor is the laxity of peritoneum and transversus muscle in this region. A longitudinal section through the gut, made so as to include the evaginated part, showed no adhesions. The rugae extended into the stricture, but beyond this point the walls were thin and smooth. Histologic examination would be necessary to determine whether any modifications in the walls themselves had resulted from the condition. It is difficult to say whether the hernia reduced itself occasionally, but the dwarfed nature of the nearby ovary suggests that it did not. The respective positions of the root of the mesentary and the hernial sac were such as to prevent the normal distension of the ovary during the process of ovulation (ripening of eggs). The few mature eggs showed flattened surfaces and suggested that the gut exercised an abnormally constant pressure here. This might have been increased by periodic food congestions in the intestine, because of impaired movement due to the stricture. Another possible factor in this connection is the presence of another and more involved intestinal hernia on the opposite or right side. There is the possibility of course, that both hernias frequently reduced themselves, and that the pressure on the more ripened eggs, as evidenced by their surfaces, was brought about through pressure of the hardening tissues in death, and through formalin.

In the second intestinal hernia mentioned above, an entire loop of the gut entered a sac of which the internal oblique muscle was the floor and the peritoneum and transversus muscle were the lateral boundaries and rim. The intestine made a sharp "V" turn to leave the sac which was located in an area just behind, and lateral to, the posterior tip of the liver. It was directed forward and upward from a point near the lateral margin of the rectus to and beyond the lateral line, and this direction indicates the direction of displacement of the gut, about 4 centimeters of the latter being involved. That this hernia was acquired fairly early, was shown by the elimination of peritoneum and transversus muscle fibres (through pressure atrophy) along the direct line of progress of the hernia. Again, its location was in a region correspondingly stronger in muscle layers, that is, dorsally and laterally. It is recalled that the sac extends dorsally beyond the lateral line, and so really involves the epaxial group of muscles. One would assume that the ventral abdominal wall would be the most favorable for hernia since the greatest pressure due to the weight of the inclosed viscera would fall in that plane. Examination and dissection show that, generally, the transversus and peritoneum compose a sheet which is

relatively less contiguous to the whole muscle mass, or less firmly bound by fascia than are the external oblique, internal oblique, and rectus muscles. This condition would operate favorably for hernias induced early or late, since the trunk, in development, first acquires the capacity of muscle movement, followed by the fore limb and then the hind limb. Again, *Necturus* is peculiar in its development in showing metameric sacculations of the gut which might be homologized with the visceral (gill) pouches. In developmental stages, these sacculations have been found to extend from one end of the gut to the other. The question of the eventual fate of these in the adult brings up the possibility of other mechanical factors which strengthen the hypothesis of a developmental origin for many of the hernias in *Necturus maculosus*. Among the conditions which promote hernia in the adult, the weak linea alba or mid-ventral line might be added. This line is irregular, broad, and transparent when the skin is removed. Unlike the higher forms, it is composed of peritoneum (that has not been materially reinforced by the insertion of the transversus muscle) and a thin coating of fascia which spans the rectus muscles of the two sides. There is a general deficiency of fascial or aponeurotic sheets which ordinarily play such a strong rôle in the support of muscles in higher forms. The union of the various muscle layers through myocommata is insufficient. Most of the animals used in the laboratory were caught with a hook, and rough handling might be the cause of some ruptures, especially in the pharyngeal region. This is improbable for the cases described because they represent old hernias.

Conclusion

The hernias here described were apparently not a great hindrance to the animal's normal activities. The evidence from anatomy shows that they developed at different intervals. Certain factors favor the hypothesis of a developmental origin for them. However, the abdominal wall is especially weak in some regions and would favor the formation of hernias in the adult.