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Acute Hemorrhagic Appendicitis in Children and Young Adults

By

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With 2 Figures in the Text

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In the course of histological examination of appendices removed because of acute appendicitis, it was noted that cases of hemorrhagic appendicitis occurred with surprising frequency in children. The incidence of these decreased with advancing age. This did not seem to be a chance observation, but rather suggested the tendency for hemorrhagic reactions to injury in the appendix of children and young adults.

In view of possible age-related differences in the manifestations of acute appendicitis, it was decided to review the clinical features of acute appendicitis in the young age group, and to study its pathological peculiarities.

Materials and Methods

The total number of appendectomies performed during a 10 year period, from April 15, 1951 to April 15, 1961, was 2,213. Of these, 1,008 (45.6%) were performed for histologically proven acute appendicitis. 1,205 (54.4%) were performed because of other forms of appendicitis. Of these, follicular lymphoid hyperplasia accounted for 18.5%. These manifested themselves clinically as appendicitis. Chronic obliterating appendicitis with fibrosis of the appendix accounted for 32% and normal appendices for 49.5%. The latter group included appendices removed prophylactically in the course of other operations. Normal appendices then accounted for a considerable percentage of the total 2,213 cases (26.8% or somewhat over 1/4 of all appendices removed during this 10 year period). The group included 14 cases containing *Oxyuris vermicularis* in the lumen with four cases demonstrating a hemorrhagic reaction around the parasite, 4 cases of carcinoid and 2 cases with mucocele.

1,008 cases of histologically proven acute appendicitis included 756 cases of purulent appendicitis (diffuse or focal inflammation) with some gangrenous perforations. The remaining 252 cases (25%) were acute hemorrhagic appendicitis. Of these, 187 cases represented mixed purulent-hemorrhagic appendicitis, and 76 (31.1%) the pure hemorrhagic form.

As is evident from the Table, the first three decades, but primarily the second decade, contained the largest percentage of acute, purulent and hemorrhagic forms. Of a total of 756 cases, 514 (67.9%) occurred in this age group. This age group also included 60 (78%) of 76 cases of hemorrhagic appendicitis. Approximately the same proportion was encountered with mixed forms — out of 176 cases, 136 were found during the first three decades.

In calculating the percentage of hemorrhagic forms among 1,008 cases of acute appendicitis, pure hemorrhagic forms accounted for 7.5% of all cases, and hemorrhagic-purulent for 17.5%. The distribution of acute appendicitis and the incidence of hemorrhagic appendicitis according to age and sex are likewise summarized in the Table.

It is of interest to note that girls and women showed a greater predilection than men to follicular lymphoid hyperplasia. Of 203 cases of lymphoid follicular hyperplasia there were only 45 cases in males, while girls and women accounted for 177 cases.

For histological examination the appendix was cut in the distal, mid and proximal portions. From each of these segments serial sections were made. In the majority of cases the most active pathological processes were located primarily in the distal end of the appendix with secondary invasion of the proximal portions.

Table. *Distribution of acute appendicitis according to age and sex*

Age	Purulent			Mixed Purulent-Hemorrhagic			Hemorrhagic			Total
	♂	♀	Total	♂	♀	Total	♂	♀	Total	
1—10	74	63	138	23	17	40	7	9	16	194
11—20	147	114	261	48	29	77	14	21	35	373
21—30	56	59	115	7	12	19	3	6	9	143
31—40	50	48	98	11	5	16	1	6	7	121
41—50	37	40	77	11	2	13	3	1	4	94
51—60	22	12	34	4	1	5	1	2	3	42
61—70	11	9	20	3	3	6	2	0	2	28
71—80	9	3	12	0	0	0	0	0	0	12
81—90	1	0	1	0	0	0	0	0	0	1
Total	408	348	756	107	69	176	31	45	76	1008

Observations

Normal Appendices. Twenty-two normal appendices were studied for comparative purposes. These included 4 appendices from newborns, 4 from infants one to five weeks of age, 4 from one to seven years of age, and 10 from adolescents and adults between 20 and 30 years of age.

In the newborn, the *lymphatic layer* was not present as such and was represented only by accumulations and groups of lymphocytes which did not form follicles. By the end of the second week this layer assumed its definite structure with early formation of follicles. These became well organized with formation of germinal centers only in the third and fourth month of life.

In appendices from newborns, reticular *stroma* was represented as an accumulation of individual reticular fibers and fibrils in the mucosa and the submucosa. These reticular fibers became thicker with increasing age and by the third and fourth week penetrated follicles and formed a reticular network. In the next four to six months of life the follicles were surrounded by layered membranes composed of individual fibers. The basement membrane of the mucosa was also thicker than in newborns and was quite prominent after the first year of life.

The *mucosa* of the newborn was thin with well developed, mucin containing goblet cells. The crypts were likewise quite distinct and penetrated deep into the developing lymphoid layer. PANETH and KULTSCHITZKY cells were not encountered at the bottom of the crypts. These were encountered only in appendices of children over two to three months of age.

The *vascular network* in the newborn was represented by thin-walled arteries and small thin-walled arterioles. The elastic fibers beneath the endothelium were not distinct, and were observed primarily in larger arteries. However, from the second to fourth week, and particularly by the sixth month, the elastic membrane thickened considerably and was distinguishable in arterioles as individual fibers which have not yet formed a continuous membrane. The internal

elastic membrane was clearly distinguishable by the first year in larger arteries and could always be demonstrated in smaller arteries in adults.

All blood vessels including both arterioles and venules were surrounded by *reticular fibers* which were not well defined in the newborn. These became prominent after the second to fourth week and formed an anchoring reticular network characterized by individual, circular fibers which were rather thin in the first six months of life. They begin to thicken by the time the child reaches about one year of age. From one year on this anchoring structure remained approximately the same and only after the second decade was there further thickening and possible increase in the size of fibers (MALININ). In the older age group reticular fibers were quite prominent, approximated each other and were attached to the adventitia of the blood vessels. In the submucosa along with the thickening of the reticular network there occurred an increase of *collagenous fibers* which gave it a fibrous tissue appearance in the older age group. The best developed reticular network in the submucosa, mucosa and perivascular spaces was found in the 3rd to 4th decades. This reticular network was prominent around follicles and was composed of individual non-joined fibers which were most prominent around the crypts of Lieberkuhn. Regardless of the state of development of the reticular perivascular network, the blood vessels were surrounded by abundant collagenous tissue.

The *endothelial lining* of the capillaries and arterioles was composed of cells with well developed junctions. The endothelial lining was PAS-positive in both children and adults. PAS-positive fibers in arterial walls, however, were more numerous in adults.

In summary, the histological analysis of normal appendices in various age groups leaves the impression of more delicate vascular structures in the younger age group as compared to the older ones. This could perhaps be explained by gradual development of the reticular network and elastic supportive structures in the vessels, and particularly by the development of a perivascular reticular network.

The histological appearance of acute hemorrhagic appendicitis was characterized by well-expressed features visible even under low magnifications. A single primary hemorrhagic focus was found in the majority of cases, multiple foci in a few. The hemorrhage usually originated in one of the mucosal crypts and broke through into the lumen (Fig. 1). Hemorrhagic extravasates in the mucosa and submucosa with perivascular accumulation of hemorrhagic infiltrates in the mucosa were common. Hemorrhagic exudate was present in the lumen of the appendix and either partially or completely filled the lumen. The hemorrhagic exudate revealed the presence of a small number of white blood cells including neutrophils. White blood cells were similarly present in the primary hemorrhage and the extravasates.

In cases of mixed purulent-hemorrhagic appendicitis the primary lesion was ordinarily found in the depth of a crypt, and consisted of purulent-hemorrhagic exudate covered with a frank hemorrhage which bulged into the lumen (Fig. 2). The purulent-hemorrhagic exudates contained threads of fibrin. As a rule the cellular covering of Lieberkuhn's glands (crypts) was either desquamated or completely absent. The surrounding reticular stromal network was slightly

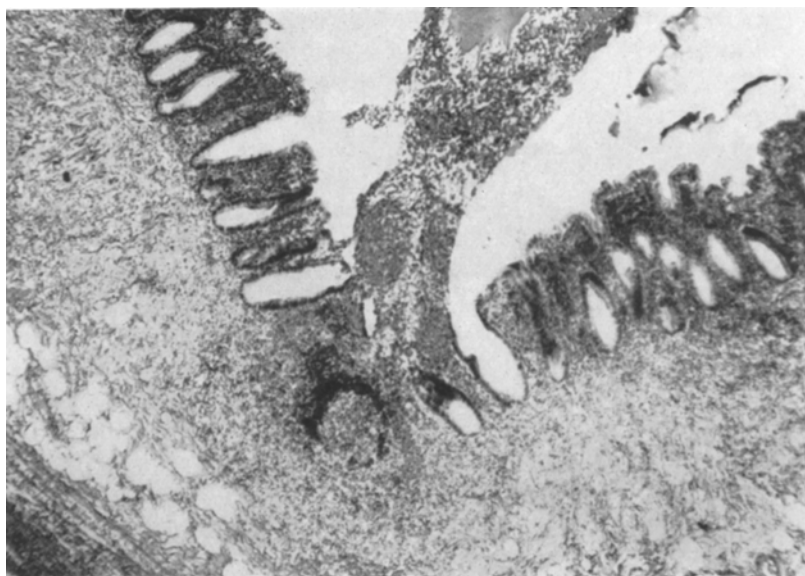


Fig. 1. Acute hemorrhagic appendicitis in a 16 year old girl. Note primary hemorrhagic focus break through into the lumen. $\times 100$. H&E

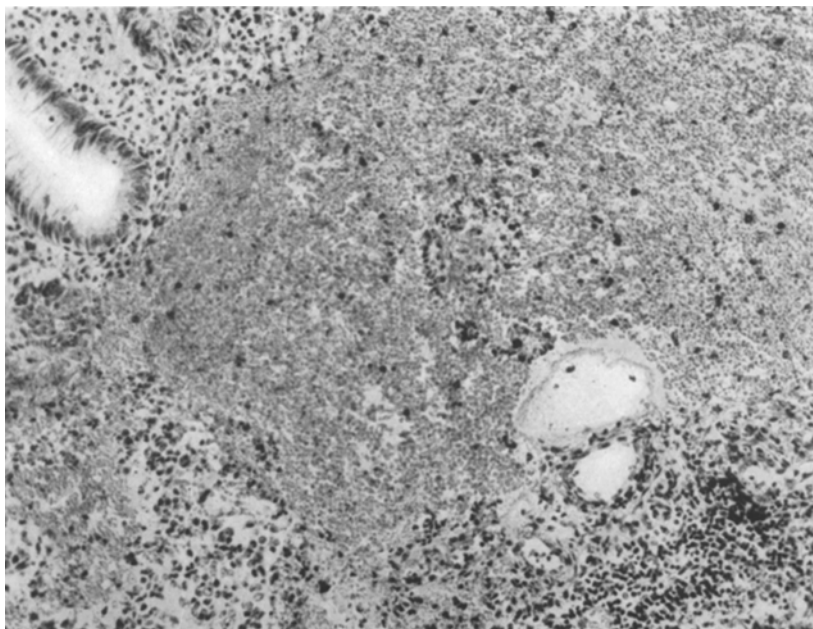


Fig. 2. Mixed purulent-hemorrhagic appendicitis in an 11 year old girl showing mixture of hemorrhagic and purulent exudates. $\times 400$. H&E

infiltrated by neutrophils or lymphocytes. The infiltration of the wall with neutrophils was absent with the exception of mixed forms where such infiltrates could be observed at the site of primary effect. The perivascular extravasations disrupted the histological structure of blood vessels, and in and around the

hemorrhage it was possible to see fragmentation and tears of the vascular walls. To this picture of hemorrhagic appendicitis in some cases was added a superficial ulceration of the mucosa which was particularly frequently encountered in mixed forms. In such cases, exudates in the lumina of the appendices contained numerous pus cells embedded in hemorrhagic masses. These findings indicate that as in purulent appendicitis the primary lesion in hemorrhagic appendicitis is inflammatory in character.

Clinical Manifestations of Hemorrhagic Forms of Acute Appendicitis. In comparison with the classical clinical picture presented by acute appendicitis of purulent, gangrenous and perforative varieties in adults, the clinical signs and symptoms in hemorrhagic forms of appendicitis were much less severe. The following clinical features were present in the majority of cases of hemorrhagic appendicitis: McBurney's point was tender. The cecal region was only partially tender, but there was spasticity and rigidity of the abdomen. Nausea with frequent vomiting was likewise present. The temperature varied from 37 to 38°C, considerably lower than in the purulent processes. The white blood cell count varied from 9,000 to 30,000 per mm³, but was usually between 9,000 and 16,000. The percentage of PMN's varied from 74—76% to 80—85%, rarely exceeding these figures.

Mixed forms of appendicitis presented a more clear-cut clinical picture with changes in peripheral blood similar to those found in purulent forms. In all cases of hemorrhagic and mixed forms of acute appendicitis the severest rebound tenderness of the abdominal wall at McBurney's point seemed to be associated with retrocecal displacement of the appendix. Of all cases of hemorrhagic appendicitis, 19% were retrocecal in position.

The length of the appendix had apparently some bearing on the severity of symptoms of acute appendicitis. The severest symptoms were present in four cases where the appendices were respectively 12, 13, 15 and 15.2 cm. long. The length of the average appendix in this series varied from 6.5 to 10.5 cm. There were 3 cases of exceedingly short appendices. These were 2.5, 3.8 and 4.2 cm. Apparently the anatomical position of the appendix, its length and fibrous adhesions around it could modify clinical manifestations of acute appendicitis in some patients.

Discussion

The subject of childhood appendicitis has been discussed by a large number of authors (BUNTON, HINDMARSH, KOLESOV, MIKERVINI and SANTULLI, and NORRIS). The majority devoted their efforts to the study of the clinical picture and surgical therapy of appendicitis in children and young adults and the evaluation of these on the basis of histopathological data without special histological examination of the removed appendices. Some authors reported that appendicitis in children, particularly in the younger age group has clinical peculiarities which sets it apart from appendicitis in adults (MIKERVINI and SANTULLI). Others, however, did not subscribe to this viewpoint. DEEVER examined 777 cases of appendicitis in children under 14 years of age and reported no peculiarities in this age group. This contention is supported by my observations as far as purulent gangrenous and perforative appendicitis in children and young adults are concerned. On the other hand hemorrhagic forms of acute appendicitis seemed to

produce much less acute clinical signs and symptoms than other forms of appendicitis.

Four authors (DANGES, NORENBURG-CHARKVIANI, SHINABERGER, THOMPSON and BUTZ, and WALKER) described the presence of hemorrhages, vascular stasis, red infarcts and thrombosis with coagulation necrosis accompanying acute inflammatory reactions in the appendix. However, not a single typical hemorrhagic infarct was found in present investigation.

BUNTON emphasized the importance of fecal masses in initiating attacks of appendicitis in children. This, no doubt, is important but would not apply to children alone.

Histological examination of the normal appendix in different age groups has been performed by many authors. Of these, most interesting ones are by HWANG and KRUMBHAR, WOOD and BLACK and BOHROD. All authors emphasized the almost complete absence of lymphoid tissue in the appendices of newborns and its gradual accumulation with the first few weeks of life, with the development of follicles during the first decade. Examination of 21 normal appendices and appendices with hemorrhagic appendicitis could add to the already existing observations that the normal follicular apparatus develops by six months of life. Concomitantly there occurs the gradual development of argentophilic fibers in the mucosa and the submucosa as well as gradual development of very delicate blood vessel structures in these layers. The full development of these structures occurred only at the end of the third decade of life.

In view of the reported observations on the development of reticular stroma, particularly around blood vessels, and the development of elastic tissues in arteries and arterioles, one may consider appendices of children to be organs with rather delicate structures. These are found primarily in the mucosa and the submucosa and include the reticular supporting structures, gradually developing lymphoid tissue, and vascular systems. This consequently suggests that in younger children the appendix might be easily subjected to injury.

Summary

The study of 1008 appendices with acute appendicitis showed 7.5% of these to be hemorrhagic. These were found primarily in children and adolescents and only rarely in adults. The pathogenesis of hemorrhagic reactions in these appendices is explained on the basis of the delicate stroma and vascular structures in the mucosa and submucosa. These seem to be more susceptible to injury than comparable structures in adults. Cases of hemorrhagic appendicitis are very infrequent when these structures have reached their final development. Follicular hyperplasia, however, occurs more frequently in girls and women.

Akute hämorrhagische Appendicitis bei Kindern und jungen Erwachsenen

Zusammenfassung

Bei Untersuchung von 1008 Wurmfortsätzen mit akuter Appendicitis erwies sie sich in 7,5% als hämorrhagisch. Diese Form der Appendicitis wurde hauptsächlich bei Kindern und Jugendlichen, nur selten bei Erwachsenen gefunden. Die Pathogenese der hämorrhagischen Reaktion wird durch den Umstand erklärt, daß das Stroma und die vasculären Strukturen in Mucosa und Submucosa sehr

zart sind; sie scheinen auch mehr empfindlich gegen Schädlichkeiten zu sein als vergleichbare Strukturen bei Erwachsenen. Dem entspricht, daß Fälle von hämorrhagischer Appendicitis seltener waren, wenn diese Strukturen ihren endgültigen Zustand erreicht hatten. Follikelhyperplasie kommt häufiger bei Frauen und Mädchen vor.

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