MECKEL'S DIVERTICULUM—
STILL A CLINICAL PROBLEM

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MECKEL'S DIVERTICULUM is a remnant of the omphalomesenteric duct. This observation was first made by Johann Meckel in 1809. Normally this embryonic structure is obliterated about the fifth to seventh week of intrauterine life. When this fails to occur the following anomalies may be found:

1. Complete or incomplete omphalomesenteric fistula.
2. Meckel's diverticulum.
3. Enterocysts.

These anomalies of the terminal ileum can display a remarkable range of pathological disorders. Bizarre cases have been described with findings quite unexpected pre-operatively (19, 23, 26, 28).

Although Meckel's diverticulum may present as an innocent finding during exploration of the abdomen, its surgical importance lies in its propensity to give rise to serious complications. These may be divided into two groups:

1. Complications caused by the diverticulum acting as a band or pouch (intestinal obstruction, diverticulitis, impaction of the diverticulum by a foreign body, tumour formation).
2. Complications derived from heterotopia (ulcer formation with the further complication of perforation and bleeding) (17).

In a total of 1,809 autopsies in children McParland and Kiesewetter (11) found Meckel's diverticulum in 1.5 per cent, and Jay et al (8) in autopsies on both children and adults found an incidence of 1.1 per cent. The incidence rates, however, given by various authors differ considerably (24).

Despite the abundant literature published about this subject since Johann Meckel first described it, it is still a source of error in diagnosis and surprise at operation. Therefore, we feel justified in publishing this analysis of 27 cases in order to point out some of the interesting clinical features.

CLINICAL MATERIAL

Twenty-seven adequately documented surgical cases of Meckel's diverticulum treated at the Royal Belfast Hospital for Sick Children from 1954 to 1967 have been reviewed. In 19 cases the diverticulum was the diagnosed cause for surgical intervention while in 8 cases it was an incidental finding in the course of other operative procedures.

Table I shows the age and sex incidence. The abnormality was found in 7 females and 20 males. It was most common in the 0–12 months age group (12 cases) and in the 1–4 years age group (11 cases). Only four cases belonged to the 5–13 years age group. It follows that over 85 per cent of patients were in the pre-school age. The average age was 3 years. The youngest patients were two infants of 1 and 3 days old respectively – both with large exomphalos. These were the only two cases with an additional congenital abnormality.
TABLE I — Age and Sex Incidence

| Age (years) | Average age | Number of Cases | Female | Male |
|-------------|-------------|----------------|--------|------|
| 1           | 5 months    | 12             | 3      | 9    |
| 1–4         | 2 1/2 years | 11             | 3      | 8    |
| 5–13        | 10 1/2 years| 4              | 1      | 3    |
| Total       | 3 years     | 27             | 7      | 20   |

TABLE II

Symptomatic and incidentally Found Meckel's Diverticula

| Symptomatic Meckel's diverticula | 19 |
| Peptic ulcer                     |    |
| — bleeding                       | 10 |
| — perforated                     |  8 |
| Intestinal obstruction           |  5 |
| — bands, volvulus                |  3 |
| — intussusception                |  2 |
| Inflammation                     |  1 |
| Bleeding – ulcer not detected    |  3 |
| Meckel's diverticula as incidental finding |  8 |

Of the eight cases (Table II) in which the diverticulum was an incidental finding the main presenting feature was abdominal pain in five, exomphalos in two and a mass in the right iliac fossa in one. In the five with abdominal pain, laparotomy failed to reveal a cause in two of them. In both of these the diverticula appeared normal on naked eye examination, lying quite free of the abdominal wall and of other surrounding intestinal structures. Microscopically, one of them was lined partly by gastric, and partly by intestinal type of mucosa; there was also a small area of pancreatic tissue. In the other three cases the clinical presentation was due to acute appendicitis, strangulated torsion of omentum, and intussusception respectively. In the latter the diverticulum was not involved. The case with a mass in the right iliac fossa proved to be a faecaloma in the caecum.

Where the diverticulum was the cause of the clinical presentation the cases were placed in one of three groups according to the associated complication:

1. Peptic ulceration.
2. Intestinal obstruction.
3. Inflammation.

Ulceration was found in 10 of these cases. In eight of them it was the source of rectal bleeding and in two it was perforated. In one of the latter the admission took place on account of rectal bleeding; perforation developed subsequently as an additional complication.

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Intestinal obstruction was seen in five cases. In two of these the diverticulum formed the leading point of an intussusception, which was in one ileo-ileal and in the other ileo-colic. In both, the Meckel's diverticulum was inverted into the lumen of the ileum and it was impossible to reduce it. Small bowel resection and end-to-end anastomosis were performed. In two further cases there was a volvulus around the Meckel's diverticulum connected to the umbilicus. In one of these the diverticulum was embedded in a three-turn volvulus involving about 8 inches of small bowel. In addition there was a 180° volvulus of the entire mid-gut. This had displaced the caecum into the left iliac fossa. In the other case of volvulus the small intestine had undergone torsion around a fibrous cord tethering the Meckel's diverticulum to the umbilicus. The fifth case of intestinal obstruction was due to constriction of the small bowel to a point on the posterior abdominal wall. The diverticulum itself showed progressive inflammatory changes which had led to gangrene and perforation.

Inflammation, or diverticulitis, occurred in only one case. This patient had a typical clinical picture of acute appendicitis. At operation, a perforated, acutely inflamed diverticulum was found. The perforation seemed to be due to inflammation rather than to peptic ulceration, and this was confirmed by subsequent histological examination. Microscopically a considerable amount of heterotopic pancreatic tissue was detected in the region of the perforation.

Histological examination of the excised diverticulum was performed in 23 of the 27 cases under discussion. Table III shows the results of this examination and the relationship between the histological findings and the complications encountered. In the 23 specimens heterotopia was revealed in 13. Heterotopic gastric mucosa was the commonest finding and was seen in nine specimens. In two further cases gastric mucosa was accompanied by pancreatic tissue. Pancreatic tissue was the only heterotopic element in two cases. The remaining diverticula were lined solely by small intestinal mucosa. In 10 of the 13 cases of heterotopia complications occurred, whereas in 10 cases with normally lined diverticula complications were encountered in only four.

Meckel's diverticulum, as the possible cause of the clinical finding, was mentioned in the pre-operative diagnosis on only six occasions, and only in cases of

| Histological finding                  | Number on histological examination | Ulcer | Bleeding | Perforation | Inflammation | Obstruction |
|---------------------------------------|-----------------------------------|-------|----------|-------------|--------------|-------------|
| Gastric mucosa                        | 9                                 | 7     | 7        | 2           | 0            | 0           |
| Gastric mucosa and pancreatic tissue | 2                                 | 0     | 1        | 0           | 0            | 0           |
| Pancreatic tissue                     | 2                                 | 0     | 0        | 0           | 1            | 1           |
| Small intestinal mucosa               | 10                                | 3     | 4        | 0           | 0            | 3           |
| **Total**                             | **23**                            | **10**| **12**   | **2**       | **1**        | **4**       |
rectal bleeding. The most common erroneous diagnosis made in those children presenting with rectal bleeding was that of intussusception. Other conditions considered with this type of presentation were rectal polyp, duodenal ulcer and purpura. In one case "Disprin" was mentioned as the possible aetiologica factor responsible for the melaena.

There were three deaths in this group of cases. In two of these the condition was complicated by small bowel obstruction; in both, severe toxemia, arising as a result, seemed to be the cause of death. In one of these there was in addition an inflammatory perforation. The third death occurred in a one-day-old child from postoperative pulmonary complications following closure of a huge exomphalos.

**DISCUSSION**

Meckel's diverticulum appears as a blind pouch on the antimesenteric border of the ileum lying free in the peritoneal cavity. According to Mason(15) this accounts for 82.5 per cent of cases. The umbilical fistula (6.3 per cent) and the fibrous band running from the apex of the diverticulum to the umbilicus or other adjacent structure (10.0 per cent) are more rarely encountered. The latter form, however, is of great interest to the surgeon for it may produce obstruction of the small bowel. In the present series such a fibrous band was found three times and in each case it was the cause of such obstruction. In the remaining 24 cases the diverticulum appeared in the form of a free-lying intestinal pouch.

Variations in its site are of some importance to the surgeon. Kiesewetter(9) found 90 per cent of these diverticula arising within 100 cm. of the ileo-caecal valve; Wandsborough et al(27) in a series of 273 children found the distance varying from 15 to 122 cm. The average distance in adults seems to be slightly longer than in children. The mean distance measured by Owen and Finney(15) in a series of 143 children and adults was 48.8 cm.

From time to time some authors have reported the presence of Meckel's diverticulum in the jejunum(12, 15) and even on the appendix(21). Sometimes the diverticulum is displaced together with the adjacent loop of bowel to unexpected regions of the abdominal cavity(28). These facts should be kept in mind when searching for it, and a minimum of 6 feet of ileum proximal to the ileo-caecal valve should be checked whenever there is reason to suspect a Meckel's diverticulum as the cause of the symptoms(5).

Pathogenic Meckel's diverticula seem to occur mostly in infants(29) The median age reported by Söderlund(24) was 5 years, and in other series published in the literature approximately half of the children with symptomatic diverticula were less than 2 years old(1, 27). By contrast, the average age of children with Meckel's diverticula as an incidental finding is reported to be higher. Söderlund(24) reports a median age of 9 for this group in his series. In the present group the mean age for the group of pathogenic diverticula was 1½ years, and nearly one-half (9 out of 19) of these children were less than one year of age, whereas the average age in the group where Meckel's diverticulum was an incidental finding was 5 years. The paediatrician should therefore remain aware of the possibility of Meckel's diverticulum as a cause of abdominal symptoms in infants, particularly as it may present in one of many guises due to its complications.

The incidence of pathologically complicated diverticula differs in various series.
Janeja and Janeja (25) showed in their report of 48 cases that the ratio of pathogenic diverticula to incidental diverticula was 9:1, where Söderlund (24) found it to be 1:2. Our figures are similar to those reported by Egan (6) – 63 per cent of cases being symptomatic.

In his classical description of the diverticulum, Meckel stated that the congenital abnormalities of the omphalo-enteric duct are often associated with other malformations. This coincidence has not been emphasised so strongly in subsequent publications on the subject (2, 24). In general a higher incidence has been found by authors investigating this problem at autopsy (27) than by surgeons at operations (24). Exomphalos seems to be the most common associated malformation in any large series, and it was the only other malformation discovered in the cases under discussion. Congenital malformations may be responsible for an increased post-operative mortality rate (14) and ought to be taken into consideration when estimating the operative risk.

The most common clinical presentation of pathogenic Meckel's diverticulum seen in our cases was rectal bleeding, ranging from melaena to massive haemorrhage with bright red blood. Intestinal bleeding was often recurrent and was occasionally a cause of severe anaemia, the lowest level of haemoglobin recorded being 3.9 gm/100 ml. (26 per cent Haldane). Intestinal bleeding was associated with ulcer formation in the Meckel's diverticulum with the exception of three cases, where no cause of bleeding could be found. In these it was interesting that, following excision, no recurrence of bleeding was noted at follow-up. Other authors, too, have found intestinal bleeding as the most common complication of this condition in children (1, 7, 18). Of the 12 cases of intestinal bleeding, eight were infants under the age of one year, the youngest being two months old, and, of the remaining four, none exceeded the age of three years. Although the complications of the diverticulum may occur at any age the literature suggests that intestinal obstruction, inflammation and haemorrhage from peptic ulceration usually occur in infants and young adults, whereas Littre's hernia and neoplasia are more characteristic of the elderly (17). Benson (1) stated that obstruction and haemorrhage are most frequently present in the first two years of life, thereafter becoming less common while the incidence of acute inflammation increases. Bleeding as a frequent symptom has also been described in tumours of Meckel's diverticulum (4, 10, 17). The incidence of these is extremely rare (29).

Peptic ulceration was the most common cause of presentation in our group. The ulcer was complicated by perforation and by bleeding. There is no typical clinical picture of perforation; the pain is unlike that in perforating gastric or duodenal ulcers. In particular, its onset is not so highly characteristic. The intensity and localization of the pain are often similar to that of appendicitis. Rigidity of the abdominal wall is usually present but it is rarely board-like in character. Thus the pain of perforated ulcer in the Meckel's diverticulum may be of little diagnostic aid and the operation is usually performed because of a presumptive diagnosis of appendicitis or intestinal obstruction (24). Rectal bleeding accompanying or preceding the signs of so-called "acute abdomen" may be of great diagnostic significance (3). The diagnosis is particularly difficult in infants for here it is impossible to evaluate the subjective feeling of pain. In one of the two cases of perforation in these cases intestinal haemorrhage preceded the sudden onset of peritonism. The other, a five
months old infant, was admitted to hospital with a three-day history of vomiting and diarrhoea. There was no intestinal bleeding. Progressive symptoms of peritonitis led to laparotomy which revealed a perforated peptic ulcer in the Meckel's diverticulum.

Intestinal obstruction was the second most common complication in this group, occurring in 29.4 per cent of the symptomatic cases (5 out of 17). In a series of 120 cases of pathogenic diverticula, Gross(7) found an incidence of 33 per cent of intestinal obstruction. Several other authors have found obstruction to be the commonest complication(24, 27). Söderlund suggests that obstructive conditions caused by Meckel's diverticulum should be classified into two groups:

1. Bands, volvulus.
2. Intussusception.

In the present series forms of obstruction belonging to both groups were encountered. Intestinal obstruction seems to be the most dangerous complication, and there is greatest danger of mortality with these patients(1, 14).

Heterotopia is a common histological finding in the diverticulum. Gastric mucosa and pancreatic tissue are found most frequently, but colonic, duodenal and biliary epithelium have also been discovered(13). The cause of this tissue dislocation has not yet been elucidated, although several theories have been proposed. The incidence of ulcer formation and associated complications seems to be closely related to the presence of gastric heterotopia. Of nine cases with gastric mucosa in the diverticulum ulcers occurred in seven, all of which were complicated either by bleeding or by perforation. The incidence of complications in the group of diverticula lined with small intestinal mucosa was significantly lower. Of 10 cases in this group bleeding was seen in four, in three of which an ulcer was found to be the cause. This astounding finding may be due to the fact that the diverticula were not examined by serial sectioning. Söderlund(24) showed that in Meckel's diverticula, gastric mucosa could be detected in about twice as many cases during the examination of serial sections as at ordinary microscopic inspection. It can be presumed that, if numerous sections are checked, diverticula which bleed will show gastric heterotopia in nearly 100 per cent of cases(31).

The review of diagnostic errors in these series indicates that the pre-operative diagnosis is difficult and rarely made, with the exception of those cases with abdominal symptoms and associated rectal bleeding. Routine barium studies of the small intestine have been very disappointing(22). The use of special radiological techniques may lead to an increase in the pre-operative detection of Meckel's diverticulum(20, 30).

In view of the serious complications of Meckel's diverticulum it would seem reasonable to advocate its removal even when it is only an incidental finding. On the other hand, a very large number are non-pathogenic and remain asymptomatic throughout life. An aggressive approach in these can only be justified when excision of the diverticulum is unlikely to increase the operative risk to the patient. A routine laparotomy should not be considered complete without a search for this congenital remnant. Until diagnosis can be made with more facility it will continue to remain an unsolved clinical problem presenting in a variety of guises and sometimes causing distressing failures in treatment.
SUMMARY

A clinical analysis of 27 cases of Meckel's diverticulum is presented. In 19 of these the diverticulum was the specific cause for surgical intervention, while in eight Meckel's diverticulum was an incidental finding. Over 85 per cent of the patients were in the pre-school age. The average age was 3 years. Pathological conditions causing the clinical symptoms are divided into three groups—peptic ulcer, intestinal obstruction and inflammation.

Peptic ulcer, found in ten cases, was complicated in eight by bleeding, and in two by perforation. Intestinal obstruction was seen in five cases and was the cause of death in two of them. An acutely inflamed diverticulum led to laparotomy in two cases. Meckel's diverticulum, as a possible cause of the clinical presentation, was only mentioned on six occasions and always in association with rectal bleeding. The overall mortality rate was 11.1 per cent—three fatal cases. The recorded observations were compared with data previously published by other authors.

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