

Surgical Management of Meckel's Diverticulum

An Epidemiologic, Population-Based Study

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Objective

The authors determined whether Meckel's diverticulum, discovered incidentally at operation, should be removed.

Summary Background Data

It is not clear from the medical literature whether the risk of an incidental Meckel's diverticulectomy is greater than the risk of leaving the diverticulum in place.

Methods

The authors used the medical experience of Olmsted County, Minnesota residents for the period 1950 to 1992 to answer the question.

Results

During the period, 58 residents developed Meckel's complications that required diverticulectomies. The incidence of complications was 87 per 100,000 person-years, and the lifetime risk (to 80 years of age) of developing them was 6.4%. The risks were similar throughout the period and at all ages of life, but were greater among men (124 per 100,000 person-years) than women (50 per 100,000 person-years, $p < 0.05$). Diverticulectomies for complications carried an operative mortality and morbidity of 2% and 12% and a cumulative risk of long-term postoperative complications of 7%, whereas incidental diverticulectomies done in 87 residents during the period carried corresponding rates of only 1%, 2%, and 2%, respectively.

Conclusions

Meckel's diverticula discovered incidentally at operation should be removed for most patients, regardless of age.

Meckel's diverticulum is the most common congenital abnormality of the gastrointestinal tract, affecting 2% of the general population.^{1,2} Although this prevalence fig-

ure is based on autopsy studies and generally is accepted, the rate of complications developing from the diverticulum remains uncertain. Johann Meckel, who described this condition in 1812,³ stated that the risk of complications was about 25%. This conclusion was repeated again in 1947 by Moses,⁴ although few data were given to substantiate it. In 1976, Soltero and Bill⁵ estimated the lifetime risk of complications from a Meckel's diverticulum to be 4.2%, with the risk decreasing with age. Recent retrospective studies also have concluded that the onset and

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frequency of complications from Meckel's diverticulum decrease during life.^{6,7} In addition, other reports^{8,9} cite a 0% to 8% risk of developing complications from removal of an incidentally discovered diverticulum found at laparotomy; however, these statements have been based on short-term follow-up. Thus, the risk of disease-related complications from a Meckel's diverticulum and the incidence of long-term postoperative complications from removal of an incidentally discovered diverticulum are not clearly known.

The aim of this study was to determine whether a Meckel's diverticulum discovered incidentally at operation should be removed. Our hypotheses were that the risks of complications from a Meckel's diverticulum are appreciable and continue unabated throughout life, and that these risks are greater than those associated with an incidental diverticulectomy. To address these hypotheses, we gathered information regarding Meckel's diverticulum among residents of Olmsted County, Minnesota, where medical care delivered to the population by all providers is documented carefully in the records of the Mayo Clinic and the Rochester Epidemiology Project. The project allowed us to determine age- and sex-specific incidence and complication rates in a well-defined population during a 42.5-year period.

MATERIALS AND METHODS

In Olmsted County, Minnesota, almost all medical care is provided by the Mayo Clinic and a small group practice, the Olmsted Medical Group. The Mayo Clinic maintains a master index to all diagnoses and procedures recorded for its patients, and the Rochester Epidemiology Project supports a similar index for the other medical care providers serving the community. This system makes possible the identification by diagnosis of all patients with any significant condition. The result is documentation of the medical care for residents of Olmsted County that is provided by the Mayo Clinic and its two hospitals (St. Mary's and Rochester Methodist), the Olmsted Medical Group and its affiliated Olmsted Community Hospital, the Rochester State (mental) Hospital, the Veterans' Administration and University of Minnesota Hospitals in Minneapolis, and other hospitals and practitioners in the vicinity. The potential of this data system for population-based studies has been described previously.¹⁰

Each case of Meckel's diverticulum was that of an Olmsted County resident who had been residing in the county for at least 1 year before initial diagnosis. For each potential case identified since 1950, the complete inpatient and outpatient medical record was abstracted for details of the Meckel's diverticulum, including presentation and operative therapy. All Olmsted County residents who underwent operation because of compli-

cations of Meckel's diverticulum during the period from January 1, 1950 to June 30, 1992 were evaluated, as was any resident who had an autopsy performed and was found to have a Meckel's diverticulum that led to death. Finally, any patient who had an incidental Meckel's diverticulectomy was evaluated for development of early and late complications associated with the diverticulectomy, such as an adhesive small bowel obstruction requiring hospitalization or operation. The protocol was approved by the Mayo Clinic Institutional Review Board on October 14, 1992.

The occurrence of diverticular complications was summarized in terms of incidence rates. In calculating these rates, only 2% of the entire population of Olmsted County (minus incidental asymptomatic subjects) was considered to be at risk; denominator age- and sex-specific person-years were derived from decennial census figures.¹¹ The age- and sex-specific rates also were directly age- or age/sex-adjusted using white U.S. residents in 1990 as the standard population. Ninety-five percent confidence intervals for these rates were estimated based on the Poisson distribution for the number of cases. Patients were observed for follow-up through their records in the community until death or the date of the last medical record entry. The cumulative lifetime risk of operation for diverticular complications was estimated from the observed incidence rates and standard 1980 death rates for Minnesota. The rates of late postoperative complications were estimated using a Kaplan-Meier life table analysis.

RESULTS

A total of 145 residents of Olmsted County, Minnesota underwent Meckel's diverticulectomies for a variety of indications between January 1, 1950 and June 30, 1992. Incidental diverticulectomies were performed, in addition to primary operations, in 87 patients; diverticulectomies were performed because of complications of the Meckel's diverticula in 58 patients (Table 1). The median age (range) for incidental cases was 37 years (4–86 years), whereas the median range for those with diverticular complications was 23 years (< 1 year–82 years). Forty-seven percent of incidental cases were men; 71% of patients with diverticular complications were men. The incidence of incidental diverticulectomy and of diverticulectomy for complications producing symptoms changed little throughout the study interval (Fig 1).

Assuming that only 2% of the general population have Meckel's diverticulum from birth, the incidence of operation for a diverticular complication was 87.4 per 100,000 person-years (95% confidence interval, 64.2–110.6) in the affected subgroup (Table 2). In those at risk, the cumulative incidence of operation for complications

Table 1. INDICATIONS FOR DIVERTICULECTOMY IN 58 SYMPTOMATIC OLMSTED COUNTY, MINNESOTA RESIDENTS WITH A MECKEL'S DIVERTICULUM

| Indication | No. of Patients* |
|-----------------|------------------|
| Hemorrhage | 16 |
| Obstruction | 15 |
| Intussusception | 1 |
| Diverticulitis | 13 |
| Perforation | 15 |
| Total | 60 |

* One patient had obstruction and perforation and another had obstruction and diverticulitis.

of Meckel's diverticulum during a lifetime (expected length of 80 years) was 6.4% (Fig 2).

More than half the subjects undergoing diverticulectomy for complications were < 30 years of age, but the likelihood of a patient with a diverticular complication requiring operation exhibited no consistent trend over age (Fig 3). The age-adjusted incidence for men (124 per 100,000 person-years), however, was greater than the age-adjusted rate for women (50 per 100,000 person-years, $p < 0.05$). The age-specific rates were greater in men than women at all ages < 60 years, although women tended to predominate thereafter (Table 2).

Of the 58 patients with complications of the Meckel's diverticulum, the surgical technique consisted of diverticulectomies in 65.5%, wedge ileal resections in 3.5%, and segmental ileal resections in 31.0%. One patient who underwent ileal resection for Meckel's diverticulitis developed cardiac failure postoperatively and died. Wound infection occurred in two patients (3%) after operation, prolonged ileus occurred in two patients (3%), and one patient developed an anastomotic leak (2%); two patients (3%) had other early postoperative complications (an overall total of seven patients [12%]). The cumulative incidence of late postoperative complications (adhesive small bowel obstruction, $n = 3$) resulting from the diverticulectomy was 7% by 20 years.

Incidentally discovered diverticula were removed in 87 patients during the same time period, by diverticulectomies in 92% of these patients, by segmental ileal resections in 6%, and by other techniques in 2%. The overall morbidity from these procedures was low, with wound infection developing in one patient; one patient had other complications (an overall rate of 2%). There was a 30-day postoperative mortality of 1%. The one death occurred in a patient who underwent a right hemicolectomy for carcinoma of the hepatic flexure and an incidental Meckel's diverticulectomy. On postoperative day

10, the patient developed a cardiac arrhythmia and died. The risk of developing long-term complications (adhesive small bowel obstruction) by 20 years after an incidental diverticulectomy was only 2%, somewhat less than the 7% rate of long-term complications after operation for complicated Meckel's diverticulum.

DISCUSSION

No consistent change in the likelihood of complications of Meckel's diverticulum occurred as subjects aged. More complications of Meckel's diverticulum seemed at first glance to occur in the younger patients, but the incidence was not clearly greater than in older subjects. The rate of complications of Meckel's diverticulum arising in men, however, was greater than in women ($p > 0.05$); there was a 6.4% overall risk of developing complications that required surgery during a lifetime for both sexes. Finally, the risk of developing long-term complications, which were largely adhesive small bowel obstructions, after removal of an incidentally discovered Meckel's diverticulum, was only 2% over 20 years, compared with 7% among the patients undergoing operations for complications of Meckel's diverticulum.

Our data support those of others who believe that prophylactic diverticulectomy is warranted to eliminate the possibility of future deaths and complications from Meckel's diverticulum.¹²⁻¹⁴ Early studies noted operative mortality rates in the range of 11%¹⁵ to 20%¹⁶ from a complication of Meckel's diverticulum; however, more recent reports give mortalities of near zero.^{8,17,18} Our study demonstrates a 30-day case fatality rate of 2% after operation for complications of the diverticulum compared with a 1% mortality in patients after incidental diverticulectomy. The two deaths in this report were not attributable to the diverticulectomy. Nonetheless, others

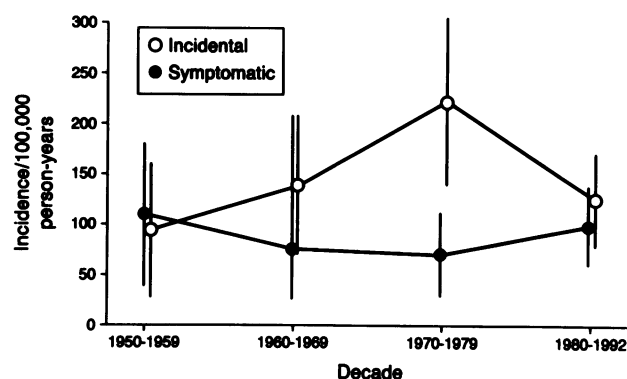


Figure 1. Age- and sex-adjusted incidence (95% confidence intervals) of diverticulectomy for cases with complications of and symptoms from Meckel's diverticulum and for cases discovered incidentally, by decade of surgery. (Age- and sex-specific rates adjusted to 1990 U.S. whites as reference populations.)

Table 2. INCIDENCE OF COMPLICATIONS OF MECKEL'S DIVERTICULUM AMONG OLMSTED COUNTY, MINNESOTA RESIDENTS, 1950-1992

| Age Interval (yr) | Women | | Men | | Total | |
|-------------------|-------|---------------------|-----|-----------------------|-------|----------------------|
| | n | Rate* | n | Rate* | n | Rate* |
| 0-9 | 0 | 0.0 | 8 | 116.7 | 8 | 59.7 |
| 10-19 | 5 | 86.4 | 10 | 180.7 | 15 | 132.5 |
| 20-29 | 4 | 63.4 | 7 | 145.1 | 11 | 99.0 |
| 30-39 | 3 | 58.8 | 4 | 82.8 | 7 | 70.4 |
| 40-49 | 0 | 0.0 | 5 | 142.9 | 5 | 68.7 |
| 50-59 | 0 | 0.0 | 6 | 230.9 | 6 | 108.0 |
| 60-69 | 2 | 87.5 | 0 | 0.0 | 2 | 49.4 |
| 70-79 | 2 | 123.2 | 0 | 0.0 | 2 | 76.7 |
| ≥80 | 1 | 105.0 | 1 | 249.9 | 2 | 149.4 |
| Total | 17 | 50.1† (25.2, 75.1)§ | 41 | 124.1† (84.8, 163.4)§ | 58 | 87.4‡ (64.2, 110.6)§ |

* Incidence per 100,000 person-years assuming that 2% of the population studied is at risk.

† Incidence per 100,000 person-years age-adjusted to the population structure of U.S. whites in 1990.

‡ Incidence per 100,000 person-years age- and sex-adjusted to the population structure of U.S. whites in 1990.

§ 95% confidence intervals for total age-adjusted and age- and sex-adjusted rates.

believe that diverticulectomy is contraindicated in the presence of acute inflammation. Early complications after operation were found in 12% of the patients who had operations for a complication of their Meckel's diverticula and in only 2% of the incidental diverticulectomy group; the late development of complications, up to 80 years of age, occurred in 7% of the patients who underwent operations for Meckel's complications compared with only 2% of the incidental ones. These figures lend support to the proponents of incidental diverticulectomy, who state that adverse outcomes are seen in only 1% to 9% of patients after incidental removal.^{7,8,15,18,19}

A number of studies have demonstrated that symptomatic Meckel's diverticulum requiring operation is more common in men than women, with a male:female ratio ranging from 2:1 to 5:1.^{13,20-23} The sex ratio here

was 2.4:1, and men outnumbered women in all age groups < 60 years of age. Although speculation, the greater frequency in men may be related to the greater risk of peptic ulceration in men than in women, at least in younger age groups. Some complications of Meckel's diverticulum, such as perforation and bleeding, are thought to be caused by peptic ulceration of the diverticulum.¹⁷

Our conclusion that nearly all incidentally discovered diverticula should be removed conflicts with those of several previous reports. Soltero and Bill⁵ estimated that the lifetime risk of developing complications from a Meckel's diverticulum was 4.2%, which decreased to zero in the older age groups. Based on their data, they suggested that prophylactic removal of an incidentally discovered Meckel's diverticulum rarely is justified. Other authors⁷ calculated a lifetime risk of complica-

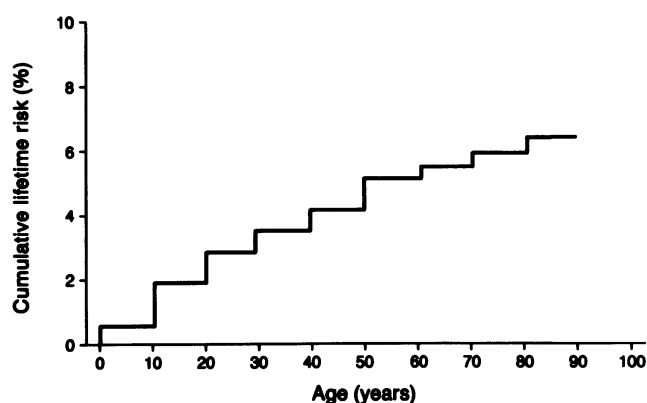


Figure 2. Cumulative lifetime risk (to age 80 years) of operation for complications of Meckel's diverticulum.

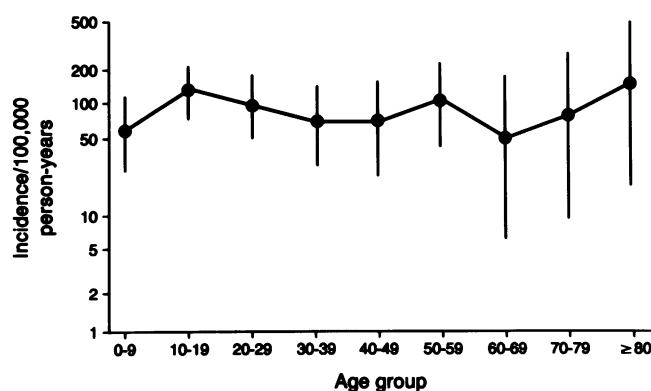


Figure 3. Age-specific incidence (95% confidence intervals) of diverticulectomy for complicated Meckel's diverticulum among Olmsted County, Minnesota residents during 1950-1992, by age group.

tions from Meckel's diverticulum of 3.7% at 16 years of age, which decreased to zero by 76 years of age. They likewise recommended that a symptomless Meckel's diverticulum be left alone. Our data, based on a population study, suggest that an incidentally discovered Meckel's diverticulum should be removed at any age up to 80 years, providing no additional condition, such as generalized peritonitis, would make removal hazardous. Short-term and long-term postoperative complications from prophylactic removal are low, and, in our series, mortality was related to the primary operation or the general health of the patient and not to the diverticulectomy. Moreover, the 6.4% rate of developing complications from the Meckel's diverticulum over a lifetime is significant. Finally, our data demonstrate that there is not a peak in the incidence of complications in childhood, even though the number of cases is greater then. Thus, incidental removal should be done in all age groups.

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Discussion

DR. DAVID TAPPER (Seattle, Washington): I would like to congratulate Dr. Kelly and his colleagues on designing a study to answer a specific clinical question: Is it appropriate to remove a clinically asymptomatic pathological entity, a Meckel's diverticulum, so as to prevent potential complications?

As you would imagine, there are an equivalent number of cited references from members of this Association who have opposing recommendations. Dr. Sandy Bill said no, Dr. Ed Passaro said yes.

So to answer this question, Dr. Kelly and his colleagues conducted an epidemiologic, population-based study on individuals living in Olmsted County, Minnesota, who received their medical care primarily from the Mayo Clinic or the Olmsted Medical Group. Both the Mayo Clinic and the Rochester Epidemiological Project maintain a master index for all diagnoses and procedures for their patients.

They found that the complications arose equally in all age groups, though more in men than in women. They have shown a 6.4% cumulative rate of developing complications present over lifetime, even though the more complicated cases were in the young, as originally shown by Dr. Bill. But the incidence is not greater.

So the complications associated with removing an incidental Meckel's are only 2%, primarily small bowel obstruction, over a 20-year period as opposed to the 7% rate for those following exploration for a symptomatic Meckel's or complication of the Meckel's.

I was probably invited as a discussant as I followed Dr. Sandy Bill as Surgeon-in-Chief at Children's in Seattle. Even more importantly, I have followed the recommendations from his 1976 paper which stated that asymptomatic Meckel's should not be removed. That paper reported a lifetime risk of 4.2%, which allegedly decreased with age.

The criticisms of the authors as to that study not being population-based are quite accurate. Sandy, though, actually taught us to evaluate the Meckel's to try and predict what would happen. He believed that the broad-based thin diverticulum without any evidence of aberrant mucosa would remain asymptomatic.