



## The Significance of Meckel's Diverticulum in Appendicitis — A Retrospective Analysis of 233 Cases

Torsten Ueberrueck, M.D.,<sup>1</sup> Lutz Meyer, M.D.,<sup>2</sup> Andreas Koch, M.D.,<sup>2</sup> Michael Hinkel, M.D.,<sup>2</sup>  
Rainer Kube, M.D.,<sup>2</sup> Ingo Gastinger, M.D., Ph.D.<sup>2</sup>

<sup>1</sup>Department of Cardiothoracic and Vascular Surgery, Friedrich-Schiller University, Erlanger-Allee 101, 07747, Jena, Germany

<sup>2</sup>Department of Surgery, Carl-Thiem-Hospital, Thiemstr. 111, 03048, Cottbus, Germany

Published Online: March 23, 2005

**Abstract.** Conflicting reports are found in the literature concerning whether to remove an incidentally discovered Meckel's diverticulum (MD). Between 1.1.1974 and 31.12.2000, at a single center, the perioperative data associated with appendectomy (AE) were recorded consecutively and analyzed retrospectively. All patients in whom an MD was discovered during an AE were included in the study. The clinical presentation, postoperative course, and follow-up in all MDs left in place were analyzed. During the course of 7927 AE, 233 MD (2.9%) were detected. Of these 80.7% ( $n = 188$ ) were removed and 19.3% ( $n = 45$ ) were left untouched. In 9% ( $n = 21$ ) of all detected diverticula pathological changes were found. Ectopic tissue was seen in 12.2% ( $n = 23$ ) of the MDs removed. The postoperative complication rates did not differ significantly between patients in whom the MD was removed (9.5%;  $n = 18$ ) and those in whom it was not (17.7%;  $n = 8$ ); in the latter group the appendicitis was of the more acute type (gangrenous or perforated) (24.4% vs. 4.3%). In 18 patients (40.0%) with non-removed MDs, a follow-up period of 14.1–5.8 years was achieved. Complications associated with a non-removed MD were not observed. If during the course of an AE a MD is detected, the present data, as well as those in the literature, suggest that an individualized approach should be taken. Meckel's diverticulum with obvious pathology should always be removed. In cases of gangrenous or perforated appendicitis, an incidentally discovered MD should be left in place, whereas in an only mildly inflamed appendix it should be removed.

The prevalence of Meckel's diverticulum (MD), named for Johann Friedrich Meckel (1781–1833), is reported to be between 2% and 3% [1–3]. More than 50% of complications associated with an MD occur in patients up to the age of 18 [4]. Typical complications are intestinal bleeding, inflammation, intussusception, and a number of rare complications (e.g., carcinoid of the MD, ileus) [5–11]. The diagnostic work-up of a symptomatic MD is determined by the clinical presentation, with bleeding presenting a particular challenge [12, 13, 14]. The question of whether a MD discovered incidentally during an appendectomy (AE) should be removed synchronously is a matter of controversial debate [15–19]. Also not

yet clarified is whether the removal of a MD has any effect on the complication rate of AE. The aim of the present study was to analyze the patients of a single center with a large number of cases over a representative period when a MD was removed as dictated by the intraoperative findings, and to analyze the follow-up situation in non-removed MD.

### Material and Methods

The study is a retrospective single-center study in which the results were subjected to a descriptive analysis.

#### Patients

Between 1.1.1974 and 31.12.2000, at the surgical department of the Carl-Thiem-Hospital, the perioperative data associated with an AE were consecutively recorded using standard forms. The diagnostic work-up comprised a medical history, the clinical findings, and laboratory investigations. A typical history showed an initial, periumbilical (epigastric) pain with a right-sided emphasis.

#### Operation

The preferred access for AE was via a McBurney incision; If peritonitis was suspected, a midline lower-abdominal laparotomy was selected. The search for MD was done by eventration of the small intestine. Since 1997, diagnostic laparoscopy has regularly been employed for AE, during the course of which the ileum is systematically inspected for MD beginning at the ileocecal (Bauhin's) valve. In the majority of patients, a grossly bland MD in the presence of acute inflammation of the vermiform appendix (gangrenous and perforating appendicitis), or of local or diffuse peritonitis, was considered a contraindication for the removal of the MD. Small and broad-based MDs measuring up to 3 cm in length with no obvious gross pathology were removed at the discretion of the surgeon.

#### Histology

Chronic inflammation of a removed MD was diagnosed historically when fibrosis of the lamina propria and lipomatous trans-

Correspondence to: Torsten Ueberrueck, M.D., e-mail: torsten.ueberrueck@med.uni-jena.de

**Table 1.** Age distribution of patients with Meckel’s diverticulum (MD; *n* = 233).

Age (years)	MD removed	MD left in place
0–10	19.7% ( <i>n</i> = 37)	13.3% ( <i>n</i> = 6)
11–20	36.2% ( <i>n</i> = 68)	26.7% ( <i>n</i> = 12)
21–30	20.2% ( <i>n</i> = 38)	17.8% ( <i>n</i> = 8)
31–40	13.3% ( <i>n</i> = 25)	13.3% ( <i>n</i> = 6)
41–50	5.8% ( <i>n</i> = 11)	6.7% ( <i>n</i> = 3)
51–60	1.6% ( <i>n</i> = 3)	13.3% ( <i>n</i> = 6)
61–70	2.1% ( <i>n</i> = 4)	2.2% ( <i>n</i> = 1)
71–80	1.1% ( <i>n</i> = 2)	4.5% ( <i>n</i> = 2)
> 80	0% ( <i>n</i> = 0)	2.2% ( <i>n</i> = 1)
Total	100% ( <i>n</i> = 188)	100% ( <i>n</i> = 45)

formation of the submucosa with an increase in lymphoid follicles was found.

*Evaluation*

Analysis of the data was performed on the basis of the above-mentioned forms and patients’ medical records. Two groups of patients were differentiated: AE with MD removal and AE without MD removal. The following parameters were analyzed: age and sex distributions, medical history, intraoperative findings, histological investigations, MD findings, and postoperative complications in relation to intraoperative findings and the comparison “MD removed/MD not removed.”

*Follow-up*

Questionnaires were mailed to patients in whom an MD was left in place, and additional information about possible gastrointestinal complications was obtained from current patient records.

*Statistics*

In addition to a descriptive analysis of the results, statistical evaluation using the chi-squared test (significance: *p* < 0.05) was carried out.

**Results**

*Patients*

In the period under review a total of 9793 AE were performed. In 19.1% of these (*n* = 1866) no search for an MD was undertaken. A statement about the existence of an MD was therefore possible in 80.9% (*n* = 7927) of all AEs. A total of 233 MDs (2.9% of the 7927 AEs) were found. Of these, 188 (80.7%) were removed, and 45 (19.3%) were left untouched. The female:male sex distribution was 1:1.5. Table 1 details the age distribution.

*Intraoperative findings*

Table 2 details the relationship between medical history and intraoperative findings. Between 1997 and 2000 a total of 311 laparoscopic AEs were performed, and 5 MDs (1.6%) were discovered. In three patients, the MD was left in place and in 2 it was removed synchronously with the laparoscopic procedure. Overall, in 9.0% (*n* = 21) of patients with an MD discovered

**Table 2.** Medical history and intraoperative findings.

Finding	Total	Medical History	
		Typical	Atypical
Only appendicitis	71.2% ( <i>n</i> = 66)	54.9% ( <i>n</i> = 128)	16.3% ( <i>n</i> = 38)
Pathological MD	9.0% ( <i>n</i> = 21)	5.6% ( <i>n</i> = 13)	3.4% ( <i>n</i> = 8)
No acute inflammation	9.9% ( <i>n</i> = 23)	4.3% ( <i>n</i> = 10)	5.6% ( <i>n</i> = 13)
Other findings	9.9% ( <i>n</i> = 23)	4.3% ( <i>n</i> = 10)	5.6% ( <i>n</i> = 13)
Total	100% ( <i>n</i> = 233)	69.1% ( <i>n</i> = 161)	30.9% ( <i>n</i> = 72)

**Table 3.** Intraoperative findings.

Finding	MD removed	MD left in place
No pathological findings	10.6% ( <i>n</i> = 20)	6.7% ( <i>n</i> = 3)
Acute appendicitis	64.4% ( <i>n</i> = 121)	57.7% ( <i>n</i> = 26)
Gangrenous appendicitis	3.7% ( <i>n</i> = 7)	6.7% ( <i>n</i> = 3)
Perforated appendicitis	0.5% ( <i>n</i> = 1)	17.8% ( <i>n</i> = 8)
Chronic appendicitis	1.6% ( <i>n</i> = 3)	0% ( <i>n</i> = 0)
Other diseases	8.0% ( <i>n</i> = 15)	11.1% ( <i>n</i> = 5)
Symptomatic MD	11.2% ( <i>n</i> = 21)	0% ( <i>n</i> = 0)
Total	100% ( <i>n</i> = 88)	100% ( <i>n</i> = 45)

during an AE the MD showed gross pathology (perforation *n* = 5, diverticulitis *n* = 10, intussusception *n* = 3, ileus caused by the MD *n* = 3). Table 3 details the intraoperative findings. In 85.6% (*n* = 161) of the cases, the diverticulectomy was performed via an open procedure, and the dissected bowel was closed with transverse sutures; in 13.3% (*n* = 25) a stapler was employed (open surgery, 12.2% (*n* = 23); laparoscopic surgery, 1.1% (*n* = 2)); and in 1.1% (*n* = 2) segmental resection of the ileum was performed. In the group in which the MD was left in place the inflammation of the appendix was more acute: MD was not removed in 11 patients out of 45 (24.4%); MD was removed in 8 of 188 (4.3%).

*Histological Findings*

In 12.2% of cases (*n* = 23) the MD was found to contain ectopic tissue. Of these, 17.4% (*n* = 4) had acute inflammatory changes. Chronically inflamed wall changes were seen in 21.2% (*n* = 40) of all MDs, with small bowel mucosa being found in 38 cases and ectopic gastric mucosa in 2 patients. Table 4 details the histological findings.

*Complications*

The postoperative complication rate was 17.7% (*n* = 8) in the group with non-removed MD, and 9.5% (*n* = 18) in the removed MD group. The differences were not significant. The wound infection rate after AE was 10.9% (*n* = 1063) in the overall group as compared with 5.9% (*n* = 11) in the group with removed MD, and was thus significantly higher (*p* = 0.028). No surgical deaths occurred. Table 5 details the complications observed.

*Follow-up*

Information on patients with non-removed MD was available for 18 of the 45 patients (40.0%). The mean follow-up was 14.1 ± 6.8 years. Five patients had died; for three of them, an autopsy report was available, but no mention was made of a MD. No complica-

**Table 4.** Histological findings from removed Meckel's diverticula.

Tissue type	Total	Inflammation stage		
		None	Acute	Chronic
Small bowel mucosa	82.5% ( <i>n</i> = 155)	54.3% ( <i>n</i> = 102)	8.0% ( <i>n</i> = 15)	20.2% ( <i>n</i> = 38)
Gastric mucosa	10.7% ( <i>n</i> = 20)	8.0% ( <i>n</i> = 15)	1.6% ( <i>n</i> = 3)	1.0% ( <i>n</i> = 2)
Pancreatic tissue	0.5% ( <i>n</i> = 1)	0.5% ( <i>n</i> = 1)	0% ( <i>n</i> = 0)	0% ( <i>n</i> = 0)
Gastric and pancreatic tissue	1.0% ( <i>n</i> = 2)	0.5% ( <i>n</i> = 1)	0.5% ( <i>n</i> = 1)	0% ( <i>n</i> = 0)
No data	5.3% ( <i>n</i> = 10)	—	—	—
Total	100% ( <i>n</i> = 188)	63.3% ( <i>n</i> = 119)	10.1% ( <i>n</i> = 19)	21.2% ( <i>n</i> = 40)

**Table 5.** Postoperative complications.

Complication	MD left in situ <i>n</i> = 45	MD removed <i>n</i> = 188	Significance ( <i>p</i> )	All AE <i>n</i> = 9793	Significance ( <i>p</i> ) all AE—MD removed
Wound infection	8.9% ( <i>n</i> = 4)	5.9% ( <i>n</i> = 11)	0.498	10.9% ( <i>n</i> = 1.63)	0.028
Ileus	2.2% ( <i>n</i> = 1)	1.6% ( <i>n</i> = 3)	0.579	0.4% ( <i>n</i> = 36)	0.037
Subphrenic/subhepatic abscess	2.2% ( <i>n</i> = 1)	0% ( <i>n</i> = 0)	—	0.03% ( <i>n</i> = 3)	—
Interenteric abscess	2.2% ( <i>n</i> = 1)	0% ( <i>n</i> = 0)	—	0.9% ( <i>n</i> = 86)	—
Diffuse peritonitis	0% ( <i>n</i> = 10)	0.5% ( <i>n</i> = 1)	—	0.3% ( <i>n</i> = 31)	—
Intraabdominal bleed	2.2% ( <i>n</i> = 1)	0.5% ( <i>n</i> = 1)	—	0.1% ( <i>n</i> = 13)	—
Gastrointestinal bleed	0% ( <i>n</i> = 0)	0.5% ( <i>n</i> = 1)	—	Not known	—
Pneumonia	0% ( <i>n</i> = 0)	0.5% ( <i>n</i> = 1)	—	0.4% ( <i>n</i> = 35)	—
Total	17.7% ( <i>n</i> = 8)	9.5% ( <i>n</i> = 18)	0.121	13.0% ( <i>n</i> = 1267)	0.188

Chi-squared test (significance *p* < 0.05).

tions due to an incidental MD left in place were seen in any of the patients who were followed up.

Discussion

Appendectomy is the most common acute visceral surgical procedure and, with an incidence of 2–3 MDs per 1 00 AE, every surgeon will be confronted with the decision whether to remove a MD or leave it alone. In view of the low incidence of 2%–3%, only retrospective studies on symptomatic and incidentally discovered MD are available [420–23]. Opponents of the removal of an incidentally discovered MD cite a possible increase in complication rate associated with its removal [3172024–26]. The present study, in contrast, shows a higher — although not significantly higher — complication rate in the group of non-removed MD (17.7% vs. 9.5%). The explanation for this is that more advanced inflammatory stages (24.4%) were seen in the appendix of this group than in the MD-removed group (4.3%). The observed wound infection rates were reported during the period before the introduction of perioperative antibiotic prophylaxis. Koch et al. [27] were able to show that the addition of perioperative antibiotic administration results in a significant reduction in local septic complications.

The question of whether more MDs are detected with diagnostic laparoscopy during AE has not yet been definitively answered. The data from the present study (5 MDs in 311 AEs) would seem to militate against this hypothesis.

Histologically, ectopic tissue was found in 12.2% of the MD, and chronic inflammatory wall changes were noted in 21.2%. Whether the chronic inflammation of MD in combination with tissue ectopia has any therapeutic relevance is controversial and can thus not support demands for prophylactic removal of an incidentally discovered MD on principle.

Although the long-term follow-up is not statistically representative, it does reveal an absence of complications in non-removed

MD. This result is also compatible with the clinical experience that surgery-requiring MD complications rarely manifest in a MD detected during an earlier AE and left untouched. However, it must be pointed out that only 40% of the patients in whom an MD was not removed were available for follow-up analysis.

In an analysis covering a period of 42 years, Cullen et al. reported a lifetime risk of developing an MD complication of 6.4% in comparison with operative morbidity and mortality rates of 2% and 12%, respectively, for diverticulectomies with complications [28]. In our own study, the complication rate for all AE was 13.0% (1267 of 9793 AEs), not significantly different from that for AEs with incidental MDs left in place. Among 15 publications reviewed, seven authors recommend removal of an incidentally discovered MD, five favored an individualized approach, and three rejected removal. Table 6 details the results of the review of the literature. In the light of the data obtained in the present study, a differentiated approach is to be recommended.

Conclusions

If a MD is detected during an AE, the present results—in comparison with the data in the literature—suggest that a differentiated approach be recommended. Meckel's diverticulum showing pathological changes should always be removed. In gangrenous or perforated appendicitis, an incidentally detected Meckel's diverticulum should be left intact. In low-grade inflammatory appendicitis, the low associated complication rate would militate in favor of removal of the MD.

References

1. Cserni G.. Gastric pathology in Meckel's diverticulum. Review of cases resected between 1965 and 1995. Am. J. Clin. Pathol. 1996;106:782–785
2. Edmonson JM.. Johann Friedrich Meckel the younger: Meckel's diverticulum. Gastrointest. Endosc. 2001;54:19A–20A

**Table 6.** Literature review of removed Meckel's diverticula.

Author name	Sympt.	Inciden.	Compt. Rate (%)	MD removal (incidental)
Cullen et al. [28]	<i>n</i> = 58	<i>n</i> = 87	2.0	Recommended
Demartines et al. [22]	<i>n</i> = 36	<i>n</i> = 55	1.9	Recommended
Carstensen and Hess [21]	<i>n</i> = 33	<i>n</i> = 122	0	Recommended
Arnold and Pellicane [16]	<i>n</i> = 13	<i>n</i> = 45	0	Recommended
Matsagas et al. [29]	<i>n</i> = 15	<i>n</i> = 15	6.6	Recommended
Kapral [30]	<i>n</i> = 26	<i>n</i> = 89	3.1	Recommended
Pinero et al. [31]	<i>n</i> = 26	<i>n</i> = 64	16.7	Recommended
Groeblí et al. [23]	<i>n</i> = 52	<i>n</i> = 67	9.0	Differentiated
Aarnio and Salonen [15]	<i>n</i> = 25	<i>n</i> = 46	8.2	Differentiated
DiGiacomo and Cottone [25]	<i>n</i> = 13	<i>n</i> = 8	50.0	Differentiated
Belelman et al. [24]	<i>n</i> = 51	<i>n</i> = 85	9.4	Differentiated
St-Vil et al. [18]	<i>n</i> = 117	<i>n</i> = 47	—	Differentiated
Fa-Si-Oen et al. [32]	<i>n</i> = 15	<i>n</i> = 12	—	Refused
Peoples et al. [3]	—	<i>n</i> = 90	2.0	Refused
Kashi and Lodge [17]	<i>n</i> = 12	<i>n</i> = 23	13.0	Refused
Own data	<i>n</i> = 21	<i>n</i> = 167	5.4	

Sympt.: number of symptomatic MD; inciden.: number of incidental MD; Compl. rate: complication rate of removed incidental MD.

3. Peoples JB, Lichtenberger EJ, Dunn MM.. Incidental Meckel's diverticulectomy in adults. *Surgery* 1995;118:649–652

4. Yahchouchy EK, Marano AF, Etienne JC, et al. Meckel's diverticulum. *J. Am. Coll. Surg.* 2001;192:658–662

5. Andrew DR, Williamson KM.. Meckel's diverticulum—rare complications and review of the literature. *J. R. Army Med. Corps.* 1994;140:143–145

6. Dixon E, Heine JA.. Incarcerated Meckel's diverticulum in a Spigelian hernia. *Am. J. Surg.* 2000;180:126

7. Dujardin M, de Beeck BODE , Osteaux M.. Inverted Meckel's diverticulum as a leading point for ileoileal intussusception in an adult: case report. *Abdom. Imaging* 2002;27:563–565

8. Fruhauf Ch , Garcia A, Rosso R.. Stromal tumor in a perforated Meckel's diverticulum: a case report. *Swiss Surg.* 2002;8. 273–276

9. Johnston AT, Khan AL, Bleakney R, et al. Stromal tumour within a Meckel's diverticulum: CT and ultrasound findings. *Br. J. Radiol.* 2001;74:1142–1144

10. Kusumoto H, Yoshitake H, Mochida K, et al. Adenocarcinoma in Meckel's diverticulum: report of a case and review of 30 cases in the English and Japanese literature. *Am. J. Gastroenterol.* 1992;87:910–913

11. Pantongrag-Brown L, Levine MS, Buetow PC, et al. Meckel's enteroliths: clinical, radiologic, and pathologic findings. *A. J. R. Am. J. Roentgenol.* 1996;167:1447–1450

12. Daneman A, Myers M, Shuckett B, et al. Sonographic appearances of inverted Meckel diverticulum with intussusception. *Pediatr. Radiol.* 1997;27:295–298

13. Shindoh N, Kurosaki A, Ozaki Y, et al. Characteristic angiographic appearance of inverted Meckel's diverticulum. *A. J. R. Am. J. Roentgenol.* 1997;169:1569–1571

14. Swaniker F, Soldes O, Hirschl RB.. The utility of technetium 99m pertechnetate scintigraphy in the evaluation of patients with Meckel's diverticulum. *J. Pediatr. Surg.* 1999;34:760–765

15. Aarnio P, Salonen IS.. Abdominal disorders arising from 71 Meckel's diverticulum. *Am. Chir. Gynaecol.* 2000;89:281–284

16. Arnold JF, Pellicane JV.. Meckel's diverticulum: a ten-year experience. *Am. Surg.* 1997;63:354–355

17. Kashi SH, Lodge JP.. Meckel's diverticulum: a continuing dilemma? *J. R. Coll. Surg. Edinb.* 1995;40:392–394

18. St-Vil D, Brandt ML, Panic S, et al. Meckel's diverticulum in children: a 20-year review. *J. Pediatr. Surg.* 1991;26:1289–1292

19. Miller LS, Barbarevech C, Friedman LS.. Less frequent causes of lower gastrointestinal bleeding. *Gastroenterol. Clin. North Am.* 1994;23:21–52

20. Amgwerd R.. When is a simultaneous operation of Meckel's diverticulum indicated: always—never—or only in special circumstances? *Langenbecks Arch. Chir.* 1986;369:179–181

21. Carstensen G, Hess W.. Meckel's diverticulum—results of 155 resections. *Langenbecks Arch Chir.* 1983;359:161–170

22. Demartines N, Herzog U, Tondelli P, et al. Meckel's diverticulum: surgical complications. *Helv. Chir. Acta* 1992;59:325–329

23. Groeblí Y, Berlin D, Morel P.. Meckel's diverticulum in adults: retrospective analysis of 119 cases and historical review. *Eur. J. Surg.* 2001;167:518–524

24. Belelman WA, Hugenholtz E, Heij HA, et al. Meckel's diverticulum in Amsterdam: experience in 136 patients. *World J. Surg.* 1995;19:734–737

25. DiGiacomo JC, Cottone FJ.. Surgical treatment of Meckel's diverticulum. *South MedJ.* 1993;86:671–675

26. Gottlieb MM, Beart RW Jr.. Surgical management of Meckel's diverticulum. *Ann. Surg* 1995;222:770

27. Koch A, Zippel R, Marusch F, et al. Prospective multicenter study of antibiotic prophylaxis in operative treatment of appendicitis. *Dig. Surg.* 2000;17:370–378

28. Cullen JJ, Kelly KA, Moir CR, et al. Surgical management of Meckel's diverticulum. An epidemiologic, population-based study. *Ann. Surg.* 1994;220:564–569

29. Matsagas MI, Fatouros M, Koulouras B, et al. Incidence, complications, and management of Meckel's diverticulum. *Arch. Surg.* 1995;130:143–146

30. Kapral W.. Meckel's diverticulum. Pro and co routine removal. *Zentralbl. Chir.* 1988;113:357–371

31. Pinero A, Martinez-Barba E, Canteras M, et al. Surgical management and complications of Meckel's diverticulum in 90 patients. *Eur. J. Surg.* 2002;168:8–12

32. Fa-Si-Oen PR, Roumen RM, van Croiset Uchelen FA.van . Complications and management of Meckel's diverticulum—a review. *Eur. J. Surg.* 1999;165:674–678