Should the appendix always be removed during surgery for mucinous ovarian tumors?

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ABSTRACT

Background: Appendectomy is performed in all mucinous ovarian tumors (MOT) identified intraoperatively to ensure microscopic metastases from appendix are not missed. Several recent studies suggested that appendectomy should only be performed in cases with a grossly abnormal appendix or with evidence of pseudomyxoma peritonei. Our study aimed to determine the frequency of malignancy in a grossly normal appendix in women undergoing surgery for borderline or malignant MOT.

Methods: In a single institution retrospective study, women undergoing surgery for MOT from January 1, 2008 to June 30, 2016 were included. Women with benign MOT, those with a history of either prior appendicectomy or prior gastrointestinal (GI) malignancy were excluded.

Results: Of 266 women identified with MOT, 153 with borderline and malignant MOT were included in the study after application of inclusion criteria. The study population comprised of 29 (18.95%) borderline and 124 (81.05%) malignant MOT. Among the borderline MOT, 13/29 had undergone appendectomy. Five (38.46%) had grossly abnormal appendices of whom 1 had mucinous cystadenoma, 3 had borderline mucinous tumor and 1 had mucinous cystadenocarcinoma of the appendix. Histology was normal in all 8 (61.54%) grossly normal appendices. Among the malignant MOT, 80/124 (64.52%) underwent appendicectomy. Nineteen (23.46%) had grossly abnormal appendices and histology was suggestive of adenocarcinoma of appendix. Histology was normal in all 62 (76.54%) macroscopically normal appendices.

Conclusions: Present results suggest that appendectomy be performed only for those appendices that are grossly abnormal or associated with pseudomyxoma peritonei at surgery for MOT

Keywords: Appendix, Borderline tumors, Malignancy, Mucinous, Ovarian tumors, Pseudomyxoma peritonei

INTRODUCTION

Mucinous ovarian tumors (MOTs) comprise 3% or less of all epithelial ovarian cancer in contrast to 12% quoted in earlier studies.1 Primary borderline and malignant MOT display overlapped morphological features including intestinal differentiation. Hence, they are often difficult to distinguish from metastatic appendiceal mucinous adenocarcinoma based on histological features and immunohistochemical (IHC) staining.2-5 In addition, proper classification of mucinous tumors as primary or metastatic intraoperatively by frozen section (FS) is limited.6 To overcome these uncertainties on FS for MOT, appendectomy can be used to rule out the possibility of metastatic disease from an occult appendiceal primary mucinous carcinoma. Hence clinical
practice guidelines in oncology outlined by the National Comprehensive Cancer Network (NCCN): Ovarian Cancer, Version 3, 2017, suggest that an appendectomy be performed in all MOT identified intraoperatively to ensure that occult or microscopic metastases from appendix are not missed.7,8 In cases with an unremarkable appendix, the mucinous neoplasm is classified as an ovarian primary.2-4,5 However, in recent years, the role of routine appendicectomy in the management of MOT has become a subject of intense debate.1 Several recent studies suggested that appendicectomy should only be performed in cases with a grossly abnormal appendix or with evidence of pseudomyxoma peritonei (PMP).1,2,6-7,9 The incidence of finding disease in a grossly normal appendix is reported to be very rare in early stages of borderline and malignant MOTs.3,10 During the past few years, several studies have suggested immunological importance of appendix for the development and preservation of the intestinal immune system.11-14 It potentially serves to reinoculate the intestine with normal flora when unfavorable pathogens arise in the gut. If the appendix is seen as a protective organ, an argument could be made for reducing or eliminating incidental appendicectomies altogether.12 Taken a step further, this may be another reason for preservation of a grossly normal appendix at least in early stages of borderline and malignant MOT.

The aim of this study was to determine the frequency of abnormal pathology in grossly normal appendices in women undergoing surgery for borderline and malignant MOT. We present the data from our institute.

METHODS

In a single institution retrospective study, we evaluated all patients who underwent surgery for MOT from January 1, 2008 to June 30, 2016, at the Department of Gynecologic Oncology, Gujarat Cancer and Research Institute, Ahmedabad, India. Inclusion criteria included borderline and malignant MOT. Exclusion criteria were women with benign MOT, a history of either prior appendicectomy or prior gastrointestinal (GI) malignancy.

Appendicectomy as part of staging MOT was performed by the gynecologic oncologist. The practice of routine appendicectomy of a normal-appearing appendix in staging laparotomy for MOT was dependent on the operating surgeon. Clinical and surgical data were collected from patient charts and the following variables the: age, operative notes (intraoperative findings, tumor laterality, gross appearance of appendix and ovaries and whether or not the appendix was removed), FS, type of surgery performed, histopathology report and IHC report. Primary ovarian cancers were staged according to International Federation of Gynecology and Obstetrics (FIGO) staging for ovarian tumors. Primary appendicular carcinomas were staged according to American Joint Committee on Cancer Staging System (AJCC) for appendiceal carcinomas.

In the study design, appendiceal involvement was categorized as gross or microscopic. In primary adenocarcinoma, the appendix is usually enlarged, deformed, cystic and may be completely destroyed. An appendix of >2 cm in diameter is often neoplastic.15 Involvement was to be considered microscopic when only histological sections were positive for malignancy and the appendix was noted to be grossly normal by the operating surgeon and pathologist.

Histopathology was reported by a consultant pathologist specialized in gynecological oncology pathology. IHC was performed to confirm primary appendiceal carcinoma with ovarian metastases as required.

Statistical analysis was performed using SPSS software. The ability of gross appearance of an appendix to assess appendiceal pathology was assessed using chi-square test. A P value of <.05 was considered statistically significant. The study was approved by the Institutional Review Committee (IRC)

RESULTS

Two hundred sixty-six patients who underwent surgery for MOT from January 1, 2008, to June 30, 2016, were evaluated. Among them 108 (40.60%) were benign, 29 (10.90%) borderline and 129 (48.49%) malignant. Among the borderline and malignant subgroup, 5 patients had a past history of appendicectomy. After application of inclusion criteria, 153 women were included in the study. Of the 153, 29 (18.95%) were borderline and 124 (81.05%) were malignant. In the borderline subgroup, the median age was 44.5 years (range, 15-70 years); and 47 years (range, 13-80 years) in the malignant subgroup.

Borderline cases

Of the 29 patients, 16 (55.17%) with grossly normal appendices did not undergo appendicectomy. Appendicectomy was performed in 13 (44.83%) patients. Eight (61.54%) had a grossly normal appendix and histology was normal in all the 8 cases. The appendix was grossly abnormal in 5 (38.46%) patients (Figure 1).

Characteristics of these 5 patients are given in Table 1. One patient had mucinous cystadenoma, 3 had borderline mucinous tumor and 1 had mucinous cystadenocarcinoma of the appendix. Of 3 patients with borderline mucinous tumor of ovary and appendix, 2 had IHC suggestive of primary appendicular tumor. In the remaining case, omentum showed changes consistent with PMP. Hence this was also considered to be a primary appendicular cancer.
Table 1: Characteristic of patients with grossly abnormal appendices in borderline MOT.

| Age | Laterality | Surgery                        | Gross appearance of appendix | Histology of Appendix | Histology of Ovary | Stage (appendicular cancer) |
|-----|------------|--------------------------------|-----------------------------|-----------------------|--------------------|--------------------------|
| 45  | Bilateral  | TAH+BSO+ appendicectomy       | Cystically dilated with mucin deposits | Borderline mucinous tumor | Borderline mucinous tumor +PMP | IVA                      |
| 48  | Unilateral | TAH+BSO+ appendicectomy       | Distended and swollen        | Mucinous cystadenoma   | Borderline mucinous tumor         | -                        |
| 50  | Unilateral | TAH+BSO+ appendicectomy       | Distended                    | Borderline mucinous tumor | Borderline mucinous tumor         | IVA                      |
| 75  | Bilateral  | TAH+BSO+ appendicectomy       | Abundant mucin in the wall and meso appendix | Mucinous cystadenoma cancer | Right- mucinous cystadenoma Left- borderline mucinous tumor | IVA                      |
| 54  | Unilateral | TAH+BSO+ appendicectomy       | Nodular                      | Borderline mucinous tumor | Borderline mucinous tumor         | IVA                      |

All cases had peritoneal washings, infracolic omentectomy as well; BSO-Bilateral Salpingo-Oophorectomy; PMP-Pseudomyxoma Peritonei; TAH-Total Abdominal Hysterectomy.

Figure 1: Gross and microscopic appearance of appendix in borderline MOT.

Malignant cases

Of the 124 patients included in the study, 43 (34.68%) did not undergo an appendicectomy, as the appendix seemed to be grossly normal intraoperatively. Appendicectomy was planned in 81 (65.32%) patients but was not feasible in 1 patient with an unresectable ileocecal mass. Of the 80 appendicectomies performed, 62 (76.54%) had a grossly normal appendix. None of these showed any appendicular disease on histopathology.

Figure 2: Gross and microscopic appearance of appendix in malignant MOT.

The appendix was grossly abnormal in 19 (23.46%) patients (Figure 2).
Characteristics of these 19 patients are given in Table 2. In 16 of the 19 patients, complete surgery could be performed. Histopathology of the 16 ovarian tumors with the grossly abnormal appendices showed well differentiated mucinous adenocarcinoma in 13 cases, moderately differentiated mucinous adenocarcinoma in 2 cases and signet ring mucinous adenocarcinoma in 1 case. In all 16 cases, similar histology was seen in both ovaries and appendices.

| Age | Laterality | Surgery | Gross appearance of appendix | Histology of appendix | Histology of ovary | Stage (appendicular cancer) |
|-----|------------|---------|------------------------------|-----------------------|-------------------|---------------------------|
| 75  | Unilateral | TAH+BSO +right hemicolecotmy | Nodular firm with mucinous surface | Mucinous adenocarcinoma | Metastatic mucinous adenocarcinoma | IVA |
| 40  | Bilateral  | BSO+ appendicectomy | Nodular hard surface | Mucinous adenocarcinoma | Metastatic mucinous adenocarcinoma | IVA |
| 42  | Bilateral  | TAH+BSO+BPLND +appendicectomy | Thickened and firm wall | Mucinous adenocarcinoma | Metastatic mucinous adenocarcinoma | IVA |
| 47  | Bilateral  | Aspiration of mucinous material from abdominal cavity+right hemicolecotmy | Distended with mucin deposits on external surface | Mucinous adenocarcinoma | Unresectable | Ovarian mass | IVA |
| 40  | Bilateral  | TAH+BSO +right hemicolecotmy | Replaced by nodular growth | Mucinous adenocarcinoma | Metastatic mucinous adenocarcinoma | IVA |
| 45  | Bilateral  | TAH+BSO+ appendicectomy | Nodular growth | Mucinous adenocarcinoma | Metastatic mucinous adenocarcinoma | IVA |
| 35  | Bilateral  | Debulking of mucinous material + peritonectomy | Mass involving appendix | Ileoceleal mass not resectable | Unresectable | Ovarian mass | IVA |
| 79  | Bilateral  | TAH+BSO+ appendicectomy | Hard nodules and thickened wall | Adenocarcinoma signet ring cell type | Metastatic adenocarcinoma signet ring cell type | IVA |
| 58  | Bilateral  | BSO+ appendicectomy | Nodular hard surface | Mucinous adenocarcinoma | Metastatic mucinous adenocarcinoma | IVA |
| 50  | Unilateral | TAH+BSO+ BPLND+ appendicectomy | Nodular with mucin on external surface | Mucinous adenocarcinoma+PMP | Metastatic mucinous adenocarcinoma+PMP | IVA |
| 65  | Bilateral  | BSO+ appendicectomy+removal of tumor over small bowel | Thickened wall with mucin externally | Mucinous adenocarcinoma | Metastatic mucinous adenocarcinoma+ PMI | IVA |
| 55  | Unilateral | TAH+BSO+ Peritonectomy+appendicectomy | Nodular | Mucinous adenocarcinoma | Metastatic mucinous adenocarcinoma | IVA |
| 35  | Bilateral  | TAH+BSO +right hemicolecotmy | Distended and cystically dilated | Mucinous adenocarcinoma | Metastatic mucinous adenocarcinoma | IVA |
| 50  | Bilateral  | BSO+right hemicolecotmy | Nodular mucinous growth | Mucinous adenocarcinoma | Metastatic mucinous adenocarcinoma | IVA |
| 50  | Bilateral  | BSO+ appendicectomy | Mucinous surface with thickened wall | Mucinous adenocarcinoma | Metastatic mucinous adenocarcinoma | IV B |
| 70  | Unilateral | USO+ appendicectomy | Distended with mucin deposits | Mucinous adenocarcinoma | Metastatic mucinous adenocarcinoma | IVB |
| 46  | Bilateral  | BSO+ appendicectomy | Nodular and hard | Mucinous adenocarcinoma | Metastatic mucinous adenocarcinoma | IVA |
| 62  | Bilateral  | Right hemicolecotmy | Friable ileocecal mass | Mucinous Adenocarcinoma | Unresectable | Ovarian mass | IVA |
| 60  | Bilateral  | TAH+BSO+ appendicectomy | Appendicular mass | Mucinous adenocarcinoma | Metastatic mucinous adenocarcinoma | IVA |

All cases had peritoneal washings, infracolic omentectomy as well; BSO: Bilateral Salpingo-Oophorectomy; USO: Unilateral Salpingo-Oophorectomy; TAH: Total Abdominal Hysterectomy; BPLND” Bilateral Pelvic Lymph Node Dissection; PMP: Pseudomyxoma Peritonei
In 3 patients’ complete surgery was not feasible. In 1 case both ovarian mass and ileocecal mass were not resectable. In this, the histology of omentum was malignant metastatic mucinous adenocarcinoma. In the remaining 2 cases, the ovarian tumors were not resectable and the histology of appendix was well differentiated mucinous adenocarcinoma in both cases.

| Malignant/borderline | CK20  | CEA  | CK7   | CA125 | CDX2 |
|----------------------|-------|------|-------|-------|------|
| Malignant            | positive | positive | focal positive | -     | -    |
| Malignant            | positive | positive | focal positive | negative | -    |
| Malignant            | positive | positive | positive   | -     | positive |
| Malignant            | positive | -     | negative  | -     | -    |
| Malignant            | positive | positive | negative  | negative | -    |
| Malignant            | positive | positive | focal positive | -     | -    |
| Malignant            | positive | positive | focal positive | negative | -    |
| Malignant            | positive | positive | focal positive | -     | -    |
| Malignant            | positive | positive | positive   | negative | -    |
| Malignant            | positive | positive | focal positive | -     | -    |
| Borderline           | positive | positive | negative  | -     | -    |
| Borderline           | positive | positive | negative  | -     | -    |
| Borderline           | positive | positive | negative  | -     | -    |

Table 4: Prediction of coexisting appendiceal pathology based on gross findings and histology of appendix.

| Type of MOT | Appendix (Gross+Histology) | P value |
|-------------|----------------------------|---------|
| Abnormal    |                           |         |
| Normal      |                           |         |
| Borderline MOT | 5     | 8      | <.05   |
| Malignant MOT | 19   | 62     | <.05   |

IHC was performed in 13 malignant and 2 borderline MOT cases. IHC profile of grossly abnormal appendices of borderline and malignant MOT is given in Table 3. All 15 cases showed CK20 and CEA positive staining. 9 cases displayed the CK20+/CK7 negative immunoprofile confirming an appendicular primary. One case with CK20/CK7 positive staining had CDX2 positive staining supporting a GI primary. 5 cases showed only focal CK7 positivity with strong CK20 staining indicating that the ovarian tumors were metastatic from appendix.

To determine if intraoperative gross appearance of appendix could predict appendiceal pathology, a chi-square test was performed (Table 4). The appendix was grossly abnormal in 19/81 cases of malignant MOT and 5/13 in borderline MOT. The ability of the gross appearance of the appendix to predict appendiceal pathology was statistically significant i.e. p-value was <0.05 in both borderline and malignant MOT.

In all 19 cases with grossly abnormal appendices, the ovarian tumor was bilateral in 12 cases. Metastatic spread was also seen on the serosal surface on the large or small bowel (16 cases), omentum (17 cases), liver surface (3 cases), undersurface of diaphragm (3 cases), abdominal wall peritoneum (3 cases), uterus (1 case) and bladder (1 case). In 1 case, there was an extensive mucin pool with tumor cells suggestive of PMP.

**DISCUSSION**

In this study, we examined the relationship between gross appearance and histology of the appendix in operated cases of MOT. Appendectomy in MOT has been the practice at our institution as in many other centers. This study aimed to question the longstanding protocol of removing even a normal-appearing appendix based on evidence that some MOTs are secondary to an occult appendiceal primary lesion.

The differential diagnosis of primary or metastatic MOT is difficult. The differential diagnosis for all MOTs particularly those that have spread beyond the ovaries includes primaries from the GI tract mainly large intestine, appendix and pancreas and less commonly stomach and biliary tract. Endocervical mucinous tumor can metastasize to the ovary in rare instances. Correct diagnosis is important not only for prognosis but also for further treatment planning.16

Primary MOTs are typically large, unilateral, multi-cystic tumors with smooth capsules and most often unassociated with an extraovarian disease. Primary mucinous ovarian carcinoma usually is associated with areas showing borderline malignancy. Mucinous carcinoma also
In the present study, appendicectomy was planned in 81 (65.32%) patients but was not feasible in 1 patient with an unresectable ileocecal mass. Among them, 19 (23.46%) were found to have a primary appendicidal tumor and with metastases to ovary and not vice versa. In all these 19 cases, the appendix was grossly abnormal. In the remaining 62 (76.54%) cases, the appendix was grossly normal. None of these were found to have appendicidal involvement on histology. Other studies also show similar findings.\cite{1,2,4,7,10} Only grossly abnormal appendices were associated with pathological findings. However, in a retrospective review of 71 patients with MOT, who underwent appendicectomy Cheng et al found metastasis from an ovary to the appendix in both cases of borderline MOT and the 1 out 5 cases of malignant MOT with grossly abnormal appendix.\cite{10}

Similarly, in borderline MOT, of the 13 patients in whom appendicectomy the, 5 (38.46%) had grossly abnormal appendices. Among these 5 patients, histological examination revealed mucinous cystadenoma in 1, mucinous adenocarcinoma in 1 and borderline mucinous tumor in 3 patients. In the remaining 8 (61.54%) patients, the appendix was grossly normal. None of these were found to have appendicidal involvement on histology. Hence it is proposed that if the appendix is grossly normal and there is no evidence of PMP, appendicectomy may be avoided. A study by Mukhopadhyay et al recommended removal of the only grossly abnormal appendix in borderline and malignant MOT. In their study, incidence of the pathologic appendix was 2.5% in borderline and 24% in malignant MOT. All patients had grossly abnormal appendix. Recently Cheng et al performed a meta-analysis of the literature (914 borderline and malignant MOT with appendicectomies) to further validate their findings. The estimated malignant pathology rate in macroscopically normal versus abnormal appendices was 1.4% and 59% respectively. They concluded that a careful intraoperative exploration of the appendix is crucial, but appendicectomy is only warranted when the appendix is abnormal.\cite{10} The result of this study is in agreement with this study as in the absence of PMP none of the normal appearing appendices showed primary or metastatic disease.

Interestingly, present results are not dissimilar from a retrospective study by Ozcan and colleagues. They included 129 patients with 120 of MOT and 9 of primary mucinous appendix carcinoma. In all 9 patients of primary appendicidal carcinoma, the appendix seemed abnormal at surgery. Of these, 4 had ovarian metastases and PMP. Pathologic diagnosis was normal in all 65 patients who underwent appendicectomy and whose appendix was grossly normal. No recurrence was detected during a median follow-up period of 7 years. Hence it appears unnecessary to perform an appendicectomy in patients operated for an adnexal mass and whose FS was reported as MOT if the appendix is grossly normal intraoperatively and there is no evidence of PMP.\cite{4}

Similarly, in a study by Lin et al, no mucinous tumors of the appendix were identified in a grossly normal appendix. There was no association between wound complication and appendicectomy.\cite{7} Feigenberg et al concluded that appendicectomy in the absence of a grossly abnormal appendix, evidence of metastatic disease or PMP at least in apparent stage I borderline and malignant MOT.\cite{8} The retrospective study by Kleppe et al recommended thorough inspection of the appendix in patients with an MOT with borderline features. An appendicectomy should only be performed when the appendix is grossly abnormal.\cite{9}

The study by Ramirez et al concluded that even though appendicectomy is not associated with complications, it should not be removed at the time of surgery for apparent early-stage ovarian cancer.\cite{18} Fontanelli and colleagues recommended appendicectomy as a part of cytoreductive surgery in advanced disease but not at staging surgery with a normal appearing appendix for ovarian carcinoma, irrespective of subtype.\cite{19}

One belief is that prior appendicectomy may offer protection against development of MOT. In a study by Elias et al, 287 cases of MOT were compared against 2339 age-matched controls from the New England case-control study. They concluded that prior appendectomy did not reduce the risk of MOT (OR 1.28, 95% CI 0.83–1.92, \(p = 0.23\)). They evaluated the frequency of microscopic, isolated appendicidal metastases from the
ovary. No microscopic metastasis was found in grossly normal appendix. Removal of appendix is mandatory if grossly abnormal or when widespread metastatic disease makes the organ of origin uncertain or in the presence of PMP as this is almost always of appendiceal origin. A thorough evaluation of the appendix intraoperatively is recommended.²

In cases where the appendix at the time of surgery for suspected MOT, IHC staining may help distinguish ovarian from appendiceal or colorectal carcinomas. Malignant MOT tends to be CK7+/CK20−/MUC2−/CDX2−, with variable expression of PAX8. In contrast, mucinous colorectal cancers and mucinous appendiceal cancers usually feature a CK7−/CK20+/MUC2+/CDX2+/PAX8− immunophenotype.² In the present study, IHC was performed in a total of 13 malignant MOT and 2 borderline MOT cases with grossly abnormal appendices. All the 15 showed CK20 and CEA positive staining and 9 displayed a CK20+/CK7 negative immunoprofile confirming an appendicular primary.

Present findings differ from those in the study by Moore and colleagues who recommended routine appendectomy in the management of all MOT. They studied 123 cases of which 119 were MOT and 4 were metastatic tumors to the ovaries. They reported a 24% prevalence of appendiceal pathology regardless of the gross appearance of the appendix. They showed 6% of occult microscopic appendiceal pathology even in a grossly normal appendix.³ Similarly, Rosendahl et al prospectively gathered data on 269 patients with confirmed malignant MOT. In their study, in 3 cases, appendix was macroscopically normal, and metastases were discovered only during microscopic evaluation. They cited many reasons for appendectomy namely complete staging, differential diagnosis of primary versus metastatic MOT, ease of performance, no increase in morbidity and the fact that a grossly normal appendix does not exclude microscopic disease. Also, risk of future appendicitis necessitating surgery is avoided.²⁰

The potential risks of performing an appendectomy for a grossly normal appendix include hemorrhage, peritonitis, intraabdominal abscess, bowel perforation, intestinal obstruction, cost, and increased time in the operating room. However, many studies including ours have shown no increase in complications from appendectomies at the time of benign and malignant gynecological surgeries.⁷ 18- ²¹ One can argue that, although the incidence of identifying a primary mucinous appendix tumor is very low, performing an appendectomy has no major negative consequences.⁹

The function of the appendix is still the subject of debate. In recent years, several studies have suggested that the appendix plays an important role in the development and preservation of intestinal immune system. The appendix harbors normal flora and can aid in repopulation of commensal bacteria and lessen the uncontrollable overgrowth of abnormal, including antibiotic-resistant bacteria in the intestine.¹¹-¹⁴ In this sense, appendectomy may be correlated with antibiotic resistance in patients with severe bacterial infections. Kawanishi concluded that prior appendectomy was an independent risk factor for the antibiotic-resistant bacteria in biliary tract infections.¹¹ Moreover, Clanton et al reported that the rate of appendectomy in the patients whose Clostridium difficile infection [CDI] led to colectomy, was significantly higher than the calculated lifetime risk, suggesting an association of appendectomy and severe CDI resulting in colectomy.¹² Considering these facts, the appendix should no longer be considered as a rudimentary organ and one must carefully decide whether appendectomy is indicated for appendicitis.

This is a large study conducted over a span of 9 years and 6 months in a tertiary care regional cancer institute with a large referral base and well established Gynecologic Oncology and Oncopathology Departments. The main limitation is the retrospective nature of clinical data. As many patients did not have appendicectomy, there may be an underestimation of incidental pathology in grossly normal appendices.

CONCLUSION

In conclusion, on the basis of the results of the present study and data previously reported in the literature, when a grossly normal appendix is removed during surgery for MOT, no primary or metastatic appendiceal tumor of mucinous histology is found. All primary mucinous appendiceal tumors were associated with the grossly abnormal appearing appendices. Careful intraoperative inspection of the appendix is mandatory.

We recommend that appendectomy be performed only for those appendices that are grossly abnormal or associated with pseudomyxoma peritonei (PMP) at the time of surgery for mucinous ovarian tumor (MOT) due to the high prevalence of primary appendiceal cancer mimicking an ovarian tumor in such cases. Unnecessary appendectomies may thus be prevented keeping in mind the proposed important immunological role of the appendix. However, further prospective studies with a larger sample size should be carried out before current recommendations can be changed.

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