

Review Article

The Benefits and Risks of Performing Incidental Appendectomy

Jin Young Lee ^a, Young Hoon Sul ^{a,b,*}, Jin Bong Ye ^a, Seung Je Go ^a, Jin Suk Lee ^a,
Hong Rye Kim ^a, Soo Young Yoon ^a, Joong Suck Kim ^c

^a Trauma Center, Chungbuk National University Hospital, Cheongju, Korea

^b Department of Trauma Surgery, College of Medicine, Chungbuk National University, Cheongju, Korea

^c Department of Trauma Surgery, Cheju Halla General Hospital, Jeju, Korea



Article history:

Received: April 5, 2019

Revised: June 3, 2019

Accepted: July 3, 2019

*Corresponding Author:

Young Hoon Sul
Department of Trauma Surgery,
College of Medicine, Chungbuk
National University, Cheongju,
Korea
E-mail: ssulyh@gmail.com
ORCID
<http://orcid.org/0000-0003-3184-3396>

ABSTRACT

Acute appendicitis is the most common indication for emergency abdominal surgery worldwide. The risks and benefits of incidental appendectomy during other operations have been debated for over a century. There is no right answer to the question of whether or not to perform incidental appendectomy. Although there are only a few indications where it is explicitly recommended such as in gynecological surgery, malrotation, and Ladd's procedure, incidental appendectomy is cost-effective in selected patient groups, especially in the young, without an increase in morbidity and mortality. In this review, the literature on incidental appendectomy was assessed from several perspectives.

Keywords: incidental appendectomy, costs and cost analysis, youth

Introduction

Acute appendicitis is the most common indication for emergency abdominal surgery and one of the most frequently performed operations in the world [1]. Appendectomy remains the gold standard of treatment for appendicitis because of its higher treatment success rate and shorter hospital stay compared with non-operative management [2]. Furthermore, some surgeons commonly perform incidental appendectomy during gynecological, urological, and digestive surgery, because of a high incidence of disease in the specimens, and the need to eliminate a differential diagnosis of "acute appendicitis" should patients present with an acute abdominal pain in the future. In addition, the ease of resection, low morbidity, and absence of additional anesthetic risks enable incidental appendectomy during non-appendiceal surgery [3-10]. On the other hand, it has been reported that incidental appendectomy contravenes

surgical principles by risking contamination, increasing operative time, and morbidity [7,11].

Incidental appendectomy is defined as the removal of a clinically normal vermiform appendix during non-appendiceal surgery [3]. The debate on the advantages and disadvantages of incidental appendectomy has been going for more than a century. There is no right or wrong answer to the question of whether or not to perform incidental appendectomy, only that previous reviews suggested surgeons must carefully consider the following points: 1) epidemiological features and lifetime risk of appendicitis and appendectomy, 2) the function of the appendix and its utility, 3) the morbidity associated with incidental appendectomy, 4) the cost-effectiveness of incidental appendectomy, 5) histological findings after incidental appendectomy [3,4,12]. This review article presents considerations regarding incidental appendectomy.

Epidemiology of Appendicitis and Appendectomy

Lee et al [13] analyzed national health insurance data collected by the Health Insurance Review Agency of South Korea from 2005 to 2007. During this period, acute appendicitis was diagnosed in 310,961 patients (approximately 103,654 per year) [13]. The overall incidence of appendicitis was 22.71 per 10,000 population per year [13]. Incidence varied with age, and the highest incidence was observed in males 10-14 years, and females 15-18 years [13]. The overall incidence of appendectomy was 13.56 per 10,000 population per year [13]. The reason for the high incidence of appendicitis and appendectomy in South Korea as compared with Western countries, was explained by a higher dietary fiber content of the Korean diet [13]. Previous studies reported that the factors that influenced the incidence of appendicitis and appendectomy were diagnostic accuracy, dietary changes, socioeconomic status, hygienic standards, and access to health services [14,15]. In the mid-20th century, these factors generally improved and therefore the incidence of appendicitis and appendectomy decreased [14-17]. Between 1979 and 1984, approximately 3.4 million appendectomies were performed in the United States, which accounted for an annual incidence of approximately 561,000 cases or 26 cases per 10,000 population [14]. The highest incidence was observed in males 10-14 years and in females 15-19 years. A Danish study showed a decrease in the incidence of uncomplicated appendicitis in young adults 10-19 years between 1996 and 2004, by 27.8% in males 10-14 years, and 12.8% in males 15-19 years [18]. A recent study in the United States demonstrated that the frequency of acute appendicitis in 10-19 year olds showed a statistically significant decrease from 1993-1996 to 2005-2008, by 4.6% [19].

Incidence of Incidental Appendectomy

In South Korea, incidental appendectomy is not acknowledged by the health insurance system. Hence, incidental appendectomy is often miscoded as appendectomy, thus it is difficult to know the exact incidence of incidental appendectomy [13]. A pathological analysis of 2,159 appendix specimens showed that incidental appendectomies were performed in 22% of cases (478 cases) [20]. In females, 34% of appendectomies were incidental, compared with 4% in males. The highest incidence was observed in females 40-49 years and males 50-59 years.

In the United States from 1979 to 1984, 62.7% of all appendectomies in females were incidental, compared with 17.7% in males [14]. The median age for incidental appendectomy was 34 years in women and 47 years in men. The primary surgical procedures performed at the time of

incidental appendectomy were abdominal hysterectomy (45%), oophorectomy or salpingectomy (37.5%), cholecystectomy (18.4%), excision of ovarian tissue (7.2%), and cesarean section (4.9%) in women, compared with cholecystectomy (36.6%), total or partial excision of the intestine (11.8%) and inguinal hernia repair (4.9%) in men.

Life Table Analysis: Risk of Appendicitis and Appendectomy

Several studies calculated the lifetime risks of appendicitis and appendectomy [12-14]. The lifetime risk of appendectomy for children under 5 years in the United States was 12% for males and 23.1% for females [14]. The lifetime risk for primary positive appendectomies (appendicitis) was 8.6% for males and 6.7% for females in this population. Overall, 2.9% of males and 16% of females may undergo incidental appendectomy in the United States [14].

The lifetime risk of appendectomy for children under 5 years in South Korea was 9.8% for males and 9.6% for females [13]. The lifetime risk for appendicitis was 16.3% for both males and females. The preventive value of incidental appendectomy in different age groups in the United States was estimated using a life table model [14]. In this study, 1,000 incidental appendectomies were performed, and prevented 16 cases of appendicitis in females under 5 years [14]. Between 1979 and 1984, approximately 260,000 incidental appendectomies were performed annually in patients under 75 years in the United States. Using the life table model, these 260,000 procedures may have prevented an estimated 7,300 future lifetime cases of acute appendicitis [14].

The Function of the Appendix

The appendix is a narrow tube-shaped sac extruding from the cecum [21]. The development of the cecum and the appendix is embryologically related to the midgut, which receives its blood supply from the superior mesenteric artery [21]. The appendix consists of lymphoid tissue and is the main site of immunoglobulin A (IgA) production in the body. It constitutes the largest concentration of gastrointestinal lymphoid tissue in the gut, and may therefore be considered a secondary lymphoid organ. In addition, it is a niche for a diverse and protective commensal gut microbiota which form biofilms. There is evidence that the appendix's microbiota may be capable of replenishing the colon's microbiota if the commensal organisms present in the colon have been depleted during diarrhea, due to exposure to pathogenic bacteria [22]. It has been reported that removal of the appendix may lead to

a higher risk of ulcerative colitis, recurrent *Clostridium difficile* infection, and myocardial and inflammatory disease [22]. Nevertheless, it is clear that most people can live unaffected without their appendix [22].

Utility of the Appendix

The appendix is a useful structure, and its preservation may have great benefits for potential future procedures in urological reconstruction, colonic irrigation, and biliary reconstruction [3].

Traumatic neurological injuries, posterior urethral valves, and congenital neurological deficits are the most common conditions requiring urologic reconstruction, and the appendix can be used in the reconstruction of the ureter [3,23].

The Malone antegrade continence enema procedure connects the cecum to the abdominal wall, using the appendix and a valve mechanism that allows catheterization and antegrade flushing of the entire length of the colon to evacuate stool. Many patients with spinal anomalies or injuries, or who have had multiple pelvic operations, suffer from fecal incontinence and may indicate that the Malone antegrade continence enema procedure could be performed in these cases using the appendix [24].

The appendix provides an anti-peristaltic, small-caliber, epithelialized, and vascularized conduit, therefore it can be used in biliary reconstruction where it reduces the occurrence of cholangitis as compared with small bowel conduits [25].

Morbidity Associated with Incidental Appendectomy

The safety of incidental appendectomy and its effect on postoperative outcomes remains controversial. Most reports on this topic are based on retrospective, uncontrolled trials.

The findings that incidental appendectomy had a high risk of morbidity are consistent with some earlier studies [26,27]. These studies compared incidental appendectomy during cholecystectomy with cholecystectomy alone, in elderly patients and showed a higher rate of wound infection in the group with appendectomy. On the other hand, a retrospective chart survey of appendectomies performed during laparotomy for trauma, showed no significant difference in the rate of wound infection, and intraabdominal sepsis [28]. A retrospective case-control study of patients who underwent incidental appendectomies during abdominal hysterectomy, reported that there were no differences in postoperative complication rates or length of hospital stay compared with patients without appendectomy [29]. A recent multi-institutional database study reported that there were no differences in mortality or all-cause morbidity, in patients

undergoing incidental appendectomy compared with those who did not [11]. However, patients older than 30 years undergoing incidental appendectomy had a higher overall risk of complications, than patients of the same age group who did not.

The safety of incidental appendectomy is controversial and prospective randomized controlled studies are needed. Nevertheless, the procedure can be relatively safe in appropriately selected patients.

Cost-effectiveness of Incidental Appendectomy

Cost-effectiveness has become an increasingly important issue when evaluating incidental appendectomy. A study by Sugimoto and Edwards [30] between 1979 and 1981 reported preventative appendicitis at a national cost of almost \$7 million. However, assuming a 10% standard appendectomy charge for incidental appendectomy, the expense for the procedure would have been more than \$20 million. More recently in 2001, Wang and Sax [31] performed a cost-benefit analysis of incidental appendectomy during laparoscopic or open procedures. In laparoscopic procedures, no savings could be shown for any age group. However, if the procedure was performed during an open operation, it was cost effective in those younger than 25 years. A similar analysis was performed by Albright et al [32] between 1999 and 2006. For patients with a benign surgical indication, incidental appendectomy was cost-effective during open operations in men younger than 55, and women younger than 50 years. For patients with malignant disease, there was a cost-benefit in men and women younger than 45 years of age. A recent study using the Markov model to simulate costs, health outcomes, and cost savings, reported that prophylactic removal of the appendix was cost saving in males 18-27 and females aged 18-28 years undergoing elective surgery [33]. The added cost of prophylactic appendectomy was about \$660. The margin of cost savings depended on the remaining years of life and increases with age.

To date there are no published studies on the cost-effectiveness of incidental appendectomy in South Korea. The most likely cause is that the health insurance system does not recognize incidental appendectomy as a procedure. Moreover, the diagnosis-related group system has been adapted for appendicitis since 2013. Therefore, further research about the cost-effectiveness of incidental appendectomy in South Korea is needed.

Histological Findings After Incidental Appendectomy

Abnormal pathological findings might be considered

as evidence supporting incidental appendectomy. The pathological analysis of 478 incidental appendectomy cases of 2,159 resected appendices in South Korea had normal findings reported in 397 of 478 cases (83.1%) of incidental appendectomy. Pathological findings included 40 cases (8.4%) of fibrous obliteration of the lumen and 32 cases (6.7%) of peri-appendicitis. Acute focal appendicitis was observed in 3 cases (0.6%), and a mucocele in 1 case (0.2%) [20].

Albright et al [32] performed an 18-year pathological survey of incidental appendectomy and recorded no pathological findings in 75.1% of specimens. Fibrous obliteration of the lumen was observed in 20.5%, while mucinous cystadenomas and mucoceles were noted in 1.2%, and carcinoid tumors in 0.9% of patients.

Conclusion

Literature on incidental appendectomy showed different perspectives to the question of whether or not to perform this procedure. Although there are only a few indications (such as in gynecological surgery, malrotation, and Ladd's procedure [3]) that incidental appendectomy was cost-effective in selected patient groups (especially in the young, without increasing morbidity and mortality). The decision to perform incidental appendectomy requires careful consideration, and future studies may be needed for different races, nations, and health insurance systems to support the surgeon's decision.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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