ORIGINAL ARTICLE

Comparison of anaesthetic cost in open and laparoscopic appendectomy

I Demirel, AB Ozer, M Kilinç, MK Bayar, OL Erhan

Department of Anesthesiology and Reanimation, Firat University Medical School, Elazig, Turkey

Abstract

Context: Appendectomy is generally conducted as open or by laparoscopic surgical techniques under general anesthesia.
Aims: This study aims to compare the anesthetic costs of the patients, who underwent open or laparoscopic appendectomy under general anesthesia.
Settings and Design: The design is retrospective and records of 379 patients who underwent open or laparoscopic appendectomy under general anesthesia, falling under the category of I-III risk group according to the American Society of Anesthesiologists (ASA) classification between the years 2011 and 2013, and aged 18-77.
Subjects and Methods: Open (Group I) or laparoscopic (Group II) appendectomy operation under general anesthesia were evaluated retrospectively by utilizing hospital automation and anesthesia observation records. This study evaluated the anesthesia time of the patients and total costs (Turkish Lira ₺, US dollar $) of anesthetic agents used (induction, maintenance), necessary medical materials (connecting line, endotracheal tube, airway, humidifier, branule, aspiration probe), and intravenously administered fluids were evaluated.
Statistical Analysis Used: We used Statistical Package for the Social Sciences software (SPSS version 17.0) for statistical analysis.
Results: Of the patients, 237 were males (62.53%) and 142 were females (37.47%). Anesthesia time limits were established as 70.30 ± 30.23 minute in Group I and 74.92 ± 31.83 minute in Group II. Mean anesthesia administration cost per patient was found to be 78.79 ± 30.01₺ (39.16 ± 14.15$) in Group I and 83.09 ± 26.85₺ (41.29 ± 13.34$) in Group II ($P > 0.05$). A correlation was observed between cost and operation times ($P = 0.002$, r = 0.158).
Conclusions: Although a statistical difference was not established in this study in terms of time and costs in appendectomy operations conducted as open and laparoscopically, changes may occur in time in market conditions of drugs, patent rights, legal regulations, and prices. Therefore, we believe that it would be beneficial to update and revise cost analyses from time to time.

Key words: Cost, cost comparison laparoscopic appendectomy, open appendectomy

Date of Acceptance: 04-Apr-2014

Introduction

Increasing expenditures of health gradually makes the cost control important. Due to high prices of modern anesthetic agents, cost control increasingly gains in importance in anesthesia practices.

Acute appendicitis is a commonly observed inflammatory disease of abdominal cavity and is treated surgically. In 1894, the surgical intervention by open method defined by McBurney (open appendectomy) has become a standard practice in treating acute appendicitis for more than a century.[1] This method is correlated with low mortality and morbidity rate, minimal pain, short hospital stay, and a complete recovery.[2] Laparoscopic appendectomy method was first defined by Seem,[3] in

Address for correspondence:
Dr. Ayse Belin Ozer,
Department of Anesthesiology and Reanimation, Firat University Medical School, 23119, Elazig, Turkey.
E-mail: abelinozer@gmail.com

Access this article online	
Quick Response Code:	**Website**: www.njcponline.com
	DOI: ***
	PMID: *******

1983, and its use gradually became widespread around the world. In some studies that included the practice of this method, it was observed that the hospital stay was shortened, there was less postoperative pain, and that it provided a shorter return to daily life activity;[4] and in some studies, its superiority over other method could not be demonstrated.[5] Today, it is observed that laparoscopic abdominal interventions (e.g., cholesystectomy) decreases the hospital stay, postoperative pain, and hospital costs, with better cosmetic appearance, and faster return to daily life.[6,7] However, superiority of laparoscopic appendectomy over other methods has not been completely demonstrated. In studies that compared the economic analyses of different surgical methods for appendectomy, results are contradictory due to small sample groups, statistical tests of cost data being inappropriate, and inability to include significant indirect costs related to the treatment.[8,9] In our literature review, we did not come across with any studies that compared anesthesia costs in different surgical method approaches to appendectomy practice.

Today, the fact that the agents used in anesthesia practice forms a wide spectrum make it necessary to investigate economic costs.[10] Considering the fact that, when a $20 worth of saving is obtained from each anesthesia practice in the United States of America, a $500 million saving could be made per annum, the significance of this issue could be much better understood.[11]

This retrospective study was planned to compare anesthesia costs in surgical approaches (open and laparoscopic) for appendectomy.

Subjects and Methods

In this study, records (hospital automation and anesthesia observation form) of 379 patients that underwent open or laparoscopic appendectomy under general anesthesia, that fall in I-III risk group according to ASA classification between the years 2011 and 2013, and aged 18-77 following the approval of the Ethics Committee of the Fırat University Medical School. Patients with history of coronary artery disease, renal failure, liver failure, chronic obstructive pulmonary disease (COPD), sensitivity to opioids, tricyclic antidepressants, benzodiazepine, anticonvulsants, clonidine, and alcohol use, pregnant and lactation mothers, and patients that underwent regional anesthesia were excluded from the study. Surgery was performed by the surgeons who have same surgical skills and experience. We included patients who had a classical appendicitis during admission to hospital and had appendicitis in terms of surgical view. Requiring additional surgical intervention, previous surgery in the area close to the surgical field, presence of adhesion, bleeding, perforation, plastron appendicitis, intra-abdominal abscess and patients with sepsis were excluded from the study. The American Society of Anesthesiologists (ASA) classifications, ages, genders, period of anesthesia, induction, and doses of drugs consumed throughout the operation (inhalation and intravenous anesthetics, muscle relaxants, and opioids) of patients were recorded.

Cases that were not pre-medicated were administered. Preoxygenation (3 min-100% O_2) and then propofol (2-3 mg/kg, 1% Fresenius®, 200 mg amp, Fresenius Kabi, Sweden), fentanyl (1 μg/kg, Abbott, USA), and vecuronium bromide (0.1 mg/kg, Norcuron® Organon, Netherlands) during the induction. Following endotracheal intubation, patients were given respiratory supports with mechanical ventilation. Patients were divided into two groups based on choice of laparotomic procedure (open, Group I) and laparoscopic (Group II) appendectomy intervention. At the end of the operation, the dosage of anesthetics used, ml-ampoule/vial for propofol, fentanyl, and vecuronium, and inhalation anesthetics were recorded according to the formula recommended in the instructions book of Dräger Cato anesthesia device manufacturer (...ml = 3× concentration × fresh gas flow× hour) and their costs were calculated taking into consideration the termination of anesthesia. Amounts of neostigmine (50 μg/kg) and atropine (20 μg/kg) used for reversing the effects of relaxants administered to patients were established and added to the total costs. Connecting line, endotracheal tube, airway, humidifier, branule, aspiration probe, and intravenous fluids necessary for infusion in addition to inhalation and intravenous anesthetics [Table 1] were also added to total costs [Table 2]. Total costs estimated for each patient were evaluated in terms of TL(₺). As at the date of this study, the exchange rate was taken into consideration as $1 = 2.012₺, and the cost was then established as $.

Data obtained by statistical evaluation were noted as mean ± standard deviation (mean ± SD). Variance

Table 1: Prices per unit agents used in the induction and maintenance of anesthesia

Intravenous and inhalation agents	Clinical sales price (₺/$)
0,5 gr Pental vial	2.27/1.12
Propofol 1% 20 ml ampoule	1.62/0.80
Sevoflurane (0,4 ml) vial	67.88/3,37
Desflurane (0,4 ml) vial	25.88/1.28
Vecuronium (1 vial)	5.19/2.57
Fentanyl (2 ml)	1.03/0.51
Neostigmine (1 ampoule)	0.35/0.17
Atropin (0,5 mg) (1 ampoule)	0.32/0.15
Metaclopromid HCL (1 ampoule)	0.39/0.19
Aritmal (% 2 ampoule)	0.67/0.33
Ultramex (Tramadol, 1 ampoule)	1.46/0.72
Metamizole Na (1 ampoule)	0.45/0.22
Ringer lactate (1000 ml)	4.84/2.40
0,9% NaCl (1000 ml)	4.83/2.40

HCL=Hydrochloric acid; NaCl=Sodium chloride

analysis (ANOVA) was used in the distribution of groups. Unpaired sample *t*-test was used for inter-group comparisons. Pearson's correlation test was implemented between anesthesia costs and operation time. $P < 0.05$ was accepted to be significant.

Results

A total of 421 operated for acute appendicitis were noted between the years 2011 and 2013. But, 42 of these patients were excluded in the study (due to complicated surgery in 28 patients, converted laparoscopic to open appendectomy in 8 patients and operated regional anesthesia in only 6 patients).

A total of 379 patients operated for acute appendicitis were included in the study. Of these patients, 237 (62.53%) were males, 142 (37.47%) were females. Of the patients that underwent open appendectomy, 138 (65.09%) were males, 74 (34.91%) were females. Of the patients that were had laparoscopic appendectomy, 99 (59.28%) were males, and 68 (40.72%) were females [Figure 1].

A statistically significant difference was not observed between the groups in terms of age, ASA score, gender, and the inhalation agents used ($P > 0.05$) [Table 3].

A significant difference was not established between the groups in terms of anaesthetic costs and operation times ($P > 0.05$) [Table 4].

When compared the operation times within themselves based on years, a significant difference was not established ($P > 0.05$).

In terms of anesthesia costs, a significant difference was observed between the years 2011 and 2012 in patients that underwent open appendectomy ($P = 0.014$) [Figure 2].

A correlation was observed between anesthesia costs and operation times ($P = 0.002$, $r = 0.158$).

A statistically significant difference was not found in the comparison of inhalation agents used in open appendectomies (Desflurane/Sevoflurane; 103/109) and inhalation agents used in laparoscopic appendectomies (Desflurane/Sevoflurane; 79/88) ($P > 0.05$).

Table 2: Prices per unit consumables used in the administration of anesthesia

Materials used	Clinical sales price (₺/$)
Endotracheal tube	1.08/0.53
Humidifier	6.99/3.47
Aspiration probe	0.76/0.37
Airway	0.32/0.15
Branule	0.33/0.16
Connecting line	0.69/0.34

Table 3: Demographic data and the inhalation agents used

	Group I	Group II	*P* value
Age (year)	42.51±15.69	41.77±17.68	0.66
ASA (I/II/III)	103/84/23	91/60/16	0.57
Gender (M/F)	138/74	99/68	0.24
İnhalations agents (desflurane/Sevoflurane)	103/109	79/88	0.85

ASA=Anesthesiologists

Table 4: Groups in terms of costs and anesthesia times

	Group I	Group II	*P* value
Anesthesia costs			
₺	78.79±30.01	83.09±26.85	0.14
$	39.16±14.15	41.29±13.34	0.14
Anesthesia times (minute)	70.30±30.23	74.92±31.83	0.14

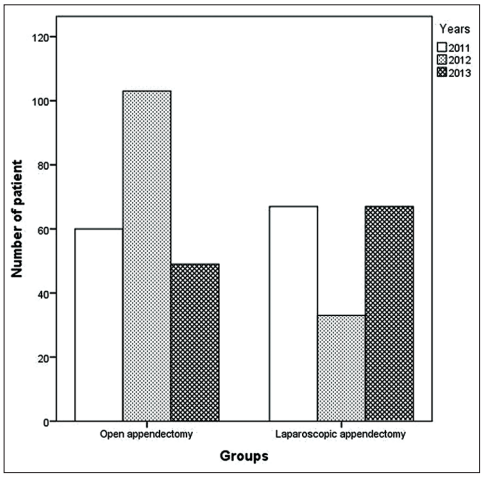

Figure 1: Number of patients according to groups

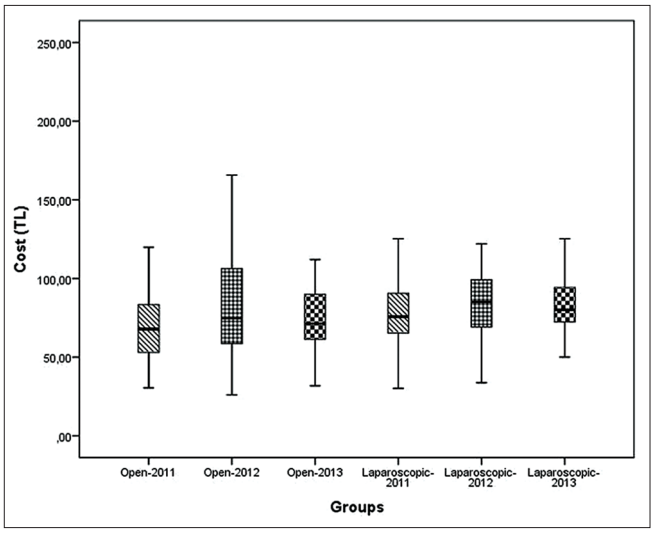

Figure 2: Anesthesia costs of groups according to years

Discussion

This study showed that the anesthesia costs in appendicitis treatment were relatively lower in open appendectomy compared to laparoscopic appendectomy but that it was not statistically significant.

It was reported that the 70-75% of surgical interventions around the world were conducted under general anesthesia and inhalation anesthesia were implemented the most.[12] In this study, patients that underwent appendectomy under general anesthesia were included, but the patients that were administered regional anesthesia were excluded from the study. Because, in our clinic, regional anesthesia does not apply except where general anesthesia is contraindicated for appendectomy operation. In surgical interventions, time of surgery may be different based on clinical experience. While, in some studies, a difference was not observed in operation times of different surgical approaches of appendectomy interventions, operation time of laparoscopic method was established to be long in some other studies.[13-17] In addition, in a study by Fukuami *et al*., operation time was found to be shorter in laparoscopic appendectomy method.[18] In our study, a statistical difference was not established between different surgical methods in terms of operation times (Laparoscopic 74.92 ± 31.83 min, Open 70.30 ± 30.23 min). We believe that the reason for this is related to the sufficient experience of surgical team in implementing laparoscopic appendectomy technique at our center.

Costs of anesthetics can be estimated per patient or hour for patients that are administered anesthesia. Total cost estimation includes direct costs formed by drugs medical materials used and the indirect costs of increasing drugs, IV sets, syringes, and agents used to eliminate the side effects.[19-21] Anesthesia implementation-related economic analysis is carried out by comparing direct costs, indirect costs, and invoice prices.[22] In our study, total anesthesia cost was estimated by considering the indirect costs hourly per patient in addition to direct costs.

Anesthesia cost was reported to be directly related with the anesthesia technique and agents.[23] While total anesthesia costs of patients that underwent laparoscopic appendectomy was 83.09 ± 26.85₺ ($41.29 ± 13.34), anesthesia costs of patients that had open appendectomy was established to be 78.79 ± 30.01₺ ($39.16 ± 14.15).

Of the hospital expenditures, surgical and operation room amounted to 1/3, and anesthesia administration expenses totaled 5.6%. The largest share of these expenses belonged to the cost of personnel.[23] It is also necessary to consider the unused amounts from ampoule or vial of IV anesthetic agents when estimating the costs. When used in ampoule form, 46% of propofol may remain. The manufacturing company recommends using propofol in a single patient and the remainder of the ampoule should not be used in another patient.[24,25] Also in our study, it was administered in the recommended way, and the costs were reflected as ampoule or vial per patient.

Despite the fact that decreasing the costs of anesthesia would also lower the hospital expenses,[26] the effect of anesthesia costs on total perioperative cost remains to be indeterminate.[27] The form of interventions and the skills of operators may cause changes in anesthesia costs.[28] Decreasing the perioperative costs in patients is the fundamental target of hospital administrators in reducing the total costs. However, healthcare policies of countries may directly affect intraoperative anesthesia costs and hospital expenses. In our study, it was established that the costs were significantly higher in the year 2012 compared to 2011 in patients that underwent appendectomy ($P = 0.014$). We believe that such a difference might be due to the price fluctuations in drugs sector in our country.

Consequently, it must be taken into consideration that the anesthesia costs may demonstrate difference between countries, or even in one country within various time frames. Prices may show changes in certain periods of time due to market conditions of the drugs used, patent rights, and legal regulations. For this reason, we believe that it would be beneficial to update studies on costs, and that cost-reducing methods should also be implemented without giving away patient safety and ethical considerations during anesthesia administrations.

References

1. McBurney C. The incision made in the abdominal wall in cases of appendicitis, with a description of a new method of operating. Ann Surg 1894;20:38-43.
2. Tzovaras G, Baloyiannis I, Kouritas V, Symeonidis D, Spyridakis M, Poultsidi A, *et al*. Laparoscopic versus open appendectomy in men: A prospective randomized trial. Surg Endosc 2010;24:2987-92.
3. Semm K. Endoscopic appendectomy. Endoscopy 1983;15:59-64.
4. Ignacio RC, Burke R, Spencer D, Bissell C, Dorsainvil C, Lucha PA. Laparoscopic versus open appendectomy: What is the real difference? Results of a prospective randomized double-blinded trial. Surg Endosc 2004;18:334-7.
5. Williams MD, Collins JN, Wright TF, Fenoglio ME. Laparoscopic versus open appendectomy. South Med J 1996;89:668-74.
6. Schirmer BD, Dix J. Cost effectiveness of laparoscopic cholecystectomy. J Laparoendosc Surg 1992;2:145-50.
7. McCahill LE, Pellegrini CA, Wiggins T, Helton WS. A clinical outcome and cost analysis of laparoscopic versus open appendectomy. Am J Surg 1996;171:533-7.
8. Fritts LL, Orlando R 3rd. Laparoscopic appendectomy. A safety and cost analysis. Arch Surg 1993;128:521-4.
9. Hiekkinen TJ, Haukipuro K, Hulkko A. Cost-effective appendectomy. Open or laparoscopic? A prospective randomized study. Surg Endosc 1998;1:1204-8.
10. Golembiewski J. Economic considerations in the use of inhaled anesthetic agents. Am J Health Syst Pharm 2010;67:S9-12.
11. Macario A, Vitez TS, Dunn B, McDonald T, Brown B. Hospital costs and severity of illness in three types of elective surgery. Anesthesiology 1997;86:92-100.
12. Daniel M. Cost of volatile anaesthetic agents. Br J Anaesth 1996;77:437.
13. Sauerland S, Lefering R, Neugebauer EA. Laparoscopic versus open surgery for suspected appendicitis. Cochrane Database Syst Rev 2004;18:CD001546.

14. Pokala N, Sadhasivam S, Kiran RP, Parithivel V. Complicated appendicitis–is the laparoscopic approach appropriate? A comparative study with the open approach: Outcome in a community hospital setting. Am Surg 2007;73:737-41.
15. Yau KK, Siu WT, Tang CN, Yang GP, Li MK. Laparoscopic versus open appendectomy for complicated appendicitis. J Am Coll Surg 2007;205:60-5.
16. Katsuno G, Nagakari K, Yoshikawa S, Sugiyama K, Fukunaga M. Laparoscopic appendectomy for complicated appendicitis: A comparison with open appendectomy. World J Surg 2009;33:208-14.
17. Lin HF, Wu JM, Tseng LM, Chen KH, Huang SH, Lai IR. Laparoscopic versus open appendectomy for perforated appendicitis. J Gastrointest Surg 2006;10:906-10.
18. Fukami Y, Hasegawa H, Sakamoto E, Komatsu S, Hiromatsu T. Value of laparoscopic appendectomy in perforated appendicitis. World J Surg 2007;31:93-7.
19. Russell LB, Siegel JE, Daniels N, Gold MR, Luce BR, Mandelblatt JS. Cost-effectiveness analysis as a guide to resource allocation in health: Roles and limitations. In: Gold M, Siegel J, Russel L, Weinstein M, editors. Cost effectiveness in health and medicine. New York: Oxford University Press; 1996:3-24.
20. Smith I, Nathanson MH, White PF. The role of sevoflurane in outpatient anesthesia. Anesth Analg 1995;81:S67-72.
21. Detsky AS, Naglie IG. A clinician's guide to cost-effectiveness analysis. Ann Intern Med 1990;113:147-54.
22. Suttner S, Boldt J, Schmidt C, Piper S, Kumle B. Cost analysis of target-controlled infusion-based anesthesia compared with standard anesthesia regimens. Anesth Analg 1999;88:77-82.
23. Macario A, Vites TS, Dunn B, McDonald T. Where are the costs in perioperative care? Analysis of hospital cost are and changes for inpatient surgical care. Anesthesiology 1995;83:1138-44.
24. Lubarsky DA, Sanderson IC, Gilbert WC, King KP, Ginsberg B, Dear GL, *et al.* Using an anesthesia information management system as a cost containment tool. Description and validation. Anesthesiology 1997;86:1161-9.
25. Heidvall M, Hein A, Davidson S, Jakobsson J. Cost comparison between three different general anaesthetic techniques for elective arthroscopy of the knee. Acta Anaesthesiol Scand 2000;44:157-62.
26. Macario A, Brock-Utne JG. Elimination of 12 and 24 Fr esophageal stethoscopes from anesthesia practice (an attempt at cost containment). Anesth Analg 1994;79:393.
27. Johnstone R, Martinec C. Costs of anesthesia. Anesth Analg 1993;76:840-8.
28. Vitez TS. Principles of cost analysis. J Clin Anesth 1994;6:357-63.

How to cite this article: ???

Source of Support: Nil, **Conflict of Interest:** None declared.