

Changes in levels of C-reactive protein in open appendectomy compared to laparoscopic appendectomy

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Abstract

Aim: The aim of this study was to compare post-operative C-reactive protein (CRP) between cases which underwent open appendectomy and laparoscopic appendectomy.

Material and methods: This study was conducted on patients admitted for appendectomy in Imam Khomeini and Razi hospitals. Patients with perforated and gangrenous appendicitis, another pathological condition, renal failure, liver failure, history of taking drugs that interact with C-reactive protein (CRP), and pregnancy were excluded from this study. Cases were divided into children (5-15 years) and adults (16-65 years). Patients were randomly selected for open or laparoscopic appendectomy. SPSS version 16.0 (SPSS Inc, Chicago, IL, USA) was used for data analysis. T-test was used for comparison. Pearson and Spearman tests were used for correlation analysis.

Results: There were no significant differences between CRP levels after laparoscopy in children vs. adult cases (p -value > 0.05 , t -test). There was no significant difference between children and adults in pre-op CRP. There were significant differences between children and adults for 12 h and 24 h level of CRP after laparoscopic appendectomy ($p < 0.05$, t -test). Mean level of CRP in adults was significantly higher than children ($p < 0.05$, t -test). Level of CRP, 12 h after the procedure, was significantly higher in open appendectomy compared to laparoscopic surgery in adult cases ($p = 0.09$, t -test). In cases with body mass index (BMI) < 25 kg/m², there was no significant difference between level of CRP before and after open or laparoscopic surgery. In cases with BMI ≥ 25 kg/m², there was no significant difference between level of CRP of open and laparoscopic surgery ($p > 0.05$, t -test). Duration of surgery had no effect on level of CRP ($p > 0.05$, t -test).

Conclusions: There was no significant difference between level of CRP after open and laparoscopic appendectomy, except in adult women. Level of CRP, 12 h and 24 h after surgery, was significantly higher in adult cases than children.

Introduction

Laparoscopic appendectomy is now considered the gold standard in most centers for the treatment of uncomplicated appendicitis in children. Surgical or accidental trauma is followed by a biological period called the acute phase response and this acute phase response may be harmful if an excessive response occurs [1, 2]. Interleukin-6 (IL-6) and IL-10 are thought to play a key role in the pathogenesis of surgical trauma. Interleukin-6 production and activation by monocytes, macrophages, and endothelial cells are an early host response to surgical trauma. Subsequently, increased serum IL-6

levels are believed to correlate with the magnitude of surgical trauma [3, 4]. Surgical trauma has been found to increase serum IL-6 values; this increase is closely associated with C-reactive protein (CRP) plasma levels [5].

Aim

The aim of this study was to compare levels of CRP between open appendectomy and laparoscopic surgery.

Material and methods

This study was conducted on patients admitted for appendectomy in Imam Khomeini and Razi hospitals.

Patients with perforated and gangrenous appendicitis, another pathological condition, renal failure, liver failure, history of taking a drug that interacts with CRP, and pregnancy were excluded from this study. Cases were divided into children (5-15 years) and adults (16-65 years). Patients were randomly selected for open or laparoscopic appendectomy. A laparoscope made by Storz (Germany) was used for the operation. SPSS ver. 16.0 (SPSS Inc, Chicago, IL, USA) was used for data analysis.

Results

Demographic features of children and adult cases are shown in Tables I and II. Duration of laparoscopic surgery was significantly longer than open surgery in both adults and children ($p < 0.05$, t -test) (Tables I and II). There was no significant difference between CRP levels after laparoscopy in children vs. adult cases (p -value > 0.05 , t -test) (Table III). There was no significant difference between children and adults in pre-op CRP. There were significant differences between children and adults for

12 h and 24 h levels of CRP after laparoscopic appendectomy ($p < 0.05$, t -test) (Table IV). There was no significant difference between children who underwent laparoscopic appendectomy versus open appendectomy for 12 h and 24 h post-operative CRP level ($p > 0.05$, t -test) (Table V). Level of CRP, 12 h after the procedure, was significantly higher in open appendectomy compared to laparoscopic surgery in adult cases ($p = 0.09$, t -test) (Table VI).

In cases with body mass index (BMI) $< 25 \text{ kg/m}^2$, there was no significant difference between level of CRP before and after open or laparoscopic surgery. In cases with BMI $\geq 25 \text{ kg/m}^2$, there was no significant difference between level of CRP of open and laparoscopic surgery ($p > 0.05$, t -test) (Table VII). In our male patients, there was no difference between open surgery with laparoscopic surgery for pre-op 12-h, and 24-h serum CRP level. For female patients, there was a significant difference between open surgery versus laparoscopic surgery for 12-h and 24-h post-surgical CRP level (Table VIII). According to time of surgery cases were divided into $< 48 \text{ h}$ and $\geq 48 \text{ h}$. In pa-

Table I. Demographic features of paediatric cases

Parameter	Open surgery	Laparoscopic
N	12	12
Age [years]	10.08 \pm 2.81	12 \pm 2.34
Sex (M/F)	4/8	6/6
BMI [kg/m ²]	22.29 \pm 2.01	20.84 \pm 2.25
Duration of surgery [min]	33.75 \pm 6.44	43.33 \pm 10.73*
Duration of clinical manifestation [h]	26.33 \pm 8.69	21.92 \pm 9.19

* $p < 0.05$, t -test

Table II. Demographic features of adult cases

Parameter	Open surgery	Laparoscopic
N	12	12
Age [years]	39.41 \pm 14.18	29.25 \pm 10.5
Sex (M/F)	6/6	8/4
BMI [kg/m ²]	23.92 \pm 2.85	23.85 \pm 10.5
Duration of surgery [min]	36.66 \pm 12.67	52.5 \pm 17.77*
Duration of clinical manifestation [h]	19.83 \pm 8.02	26.5 \pm 13.16

* $p < 0.05$, t -test

Table III. Comparison between children and adults among cases which underwent laparoscopic appendectomy

CRP	Children	Adults	Value of p
Pre-op [mg/l]	23.3 \pm 16.4	33.3 \pm 25.4	0.26
12 h after op [mg/l]	27.4 \pm 54.6	76.8 \pm 51.4	0.20
24 h after op [mg/l]	87.0 \pm 37.9	113.9 \pm 68.4	0.24

Table V. Comparison of CRP among children cases which underwent open vs. laparoscopic surgery

CRP	Open	Laparoscopic	Value of p
Pre-op [mg/l]	15.9 \pm 7.3	23.3 \pm 16.4	0.17
12 h after op [mg/l]	60.0 \pm 29.9	54.6 \pm 27.4	0.64
24 h after op [mg/l]	84.0 \pm 26.2	87.0 \pm 37.9	0.82

Table IV. Comparison between children and adults cases which underwent open appendectomy

CRP	Children	Adults	Value of p
Pre-op [mg/l]	15.9 \pm 7.3	53.8 \pm 50.0	0.24
12 h after op [mg/l]	60.0 \pm 29.9	118.2 \pm 64.2	0.009
24 h after op [mg/l]	84.0 \pm 26.2	154.2 \pm 62.8	0.002

Table VI. Comparison of CRP among adult cases which underwent open vs. laparoscopic surgery

CRP	Open	Laparoscopic	Value of p
Pre-op [mg/l]	53.8 \pm 50.0	33.3 \pm 25.4	0.22
12 h after op [mg/l]	118.2 \pm 64.2	76.8 \pm 51.4	0.09
24 h after op [mg/l]	154.2 \pm 62.8	113.9 \pm 68.4	0.14

Table VII. Comparison of CRP in relation to BMI

CRP	BMI < 25 kg/m ²			BMI ≥ 25 kg/m ²		
	Open	Laparoscopy	Value of <i>p</i>	Open	Laparoscopy	Value of <i>p</i>
Pre-op [mg/l]	24.3 ±23.0	25.6 ±20.3	0.82	76.2 ±61.7	38.3 ±25.5	0.25
12 h after op [mg/l]	74.4 ±40.8	58.2 ±32.3	0.18	145.0 ±80.1	94.3 ±63.9	0.30
24 h after op [mg/l]	105.3 ±39.6	92.7 ±46.7	0.37	171.8 ±93.3	129.6 ±82.0	0.47

Table VIII. CRP changes among males and females

CRP	Female			Male		
	Open	Laparoscopy	Value of <i>p</i>	Open	Laparoscopy	Value of <i>p</i>
Pre-op [mg/l]	32.4 ±26.6	20.3 ±12.1	0.57	44.7 ±40.8	34.0 ±25.2	0.62
12 h after op [mg/l]	92.3 ±37.5	55.0 ±23.0	0.04*	54.0 ±25.2	73.4 ±50.8	0.56
24 h after op [mg/l]	118.0 ±35.8	87.7 ±37.0	0.01*	86.8 ±69.4	109.5 ±65.9	0.69

**p* < 0.05

tients who underwent surgery in < 48 h, there was no significant difference between open and laparoscopic surgery. In cases which underwent surgery ≥ 48 h, there was no significant difference between laparoscopic appendectomy versus open surgery (Table IX). Duration of surgery had no effect on level of CRP (*p* > 0.05, t-test) (Table X).

Discussion

In the current study, there was no significant difference between 12 h and 24 h postoperative CRP levels between open and laparoscopic surgery. Li *et al.* compared 69 children who underwent laparoscopic appendectomy with 91 open cases. They found that CRP and IL-6 levels did not differ, but the peri-operative elevation of both factors was significantly less pronounced after the laparoscopic procedure [6]. In the Sietses *et al.* study, the influence of laparoscopic surgery on the postoperative immune response was significantly less than con-

ventional methods [7]. In the Nguyen *et al.* study, magnitude and duration of impaired cellular immunity after laparoscopic surgery was less than after open surgery [8]. The difference between our study and other studies may be due to the type of the cases, age, distribution of sex, and duration of laparoscopy, because in our study, duration of laparoscopy was longer than open surgery.

In our study, post-operative level of CRP (12 h and 24 h) was significantly lower in children than adults. This may be due to differences in immune response or tissue texture between children and adults.

In female cases, there was a significantly lower level of CRP following laparoscopy compared to open surgery. There is some evidence that the immune response is less pronounced after laparoscopic surgery compared to open surgery [9, 10].

In males, the post-operative CRP level was higher in laparoscopy compared to open surgery. We expected

Table IX. Comparison between CRP levels according to time of surgery

CRP	T < 48 h			T ≥ 48 h		
	Open	Laparoscopy	Value of <i>p</i>	Open	Laparoscopy	Value of <i>p</i>
Pre-op [mg/l]	40.7 ±35.5	25.9 ±18.0	0.31	20.5 ±0.0	44.6 ±40.3	0.65
12 h after op [mg/l]	90.6 ±58.1	64.6 ±41.6	0.09	56.0 ±0.0	73.6 ±52.0	0.79
24 h after op [mg/l]	121.7 ±59.1	94.4 ±52.3	0.11	60.0 ±0.0	142.7 ±73.1	0.43

Table X. Comparison between CRP levels according to duration of surgery

CRP	Open			Laparoscopy		
	< 30 min	≥ 30 min	Value of <i>p</i>	< 40 min	≥ 40 min	Value of <i>p</i>
Pre-op [mg/l]	31.2 ±24.2	44.7 ±42.5	0.27	29.5 ±27.2	28.6 ±19.2	0.91
12 h after op [mg/l]	64.5 ±39.6	106.7 ±62.5	0.07	59.3 ±42.8	67.9 ±42.6	0.67
24 h after op [mg/l]	100.0 ±30.6	132.8 ±71.2	0.14	99.2 ±73.5	100.8 ±51.2	0.96

that the CRP level following laparoscopy would be lower than after open surgery, but this unexpected CRP level may be due to a conflicting factor such as degree of inflammation, progression of disease, or antibiotic usage. This difference needs further study.

In our study, the operative time of laparoscopic surgery was longer than open appendectomy in children and adults. This longer operative time in laparoscopic surgery may be the reason for the smaller difference between CRP levels in laparoscopic surgery compared to open appendectomy. As the time of surgery is prolonged the magnitude of trauma may be increased. The majority of literature reported that the operating time of laparoscopic appendectomy was longer than operative appendectomy [11, 12]. In the Li *et al.* study, the operative time of laparoscopy was shorter than open appendectomy [6].

Karadayi *et al.* studied 81 cases that underwent surgery due to acute appendicitis. The acute phase reactant level was significantly lower in the laparoscopic appendectomy group than in the open appendectomy group ($p < 0.05$). In their study, there was no significant difference in operation time between the two groups ($p > 0.05$) [13]. In our study, the operation time in the laparoscopic group was significantly longer than the open appendectomy group.

Hildebrandt *et al.* studied cases that underwent colonic resection by open or laparoscopic surgery [14]. They found that laparoscopic and open colonic resection caused a significant increase in serum CRP, IL-6, and IL-10. The comparison between laparoscopic and open surgery showed significantly lower levels of CRP, IL-6, and IL-10 after laparoscopic surgery compared to open surgery [14]. In their study, for the first 3 post-operative days, CRP showed a significantly lower level in cases that underwent laparoscopy compared to open surgery [14]. Because CRP is a non-specific marker of an acute phase reaction, CRP levels have not always reflected the magnitude of actual trauma after open or laparoscopic surgery [15].

Wu *et al.* studied cases that underwent colonic resection by laparoscopy versus open surgery [16]. Serum CRP level was significantly higher than baseline values in both methods. There was no significant difference between the two methods [16]. Luo *et al.* studied 26 cases that underwent cholecystectomy. Of 26 cases, 14 cases underwent laparoscopic cholecystectomy. The post-operative CRP level was significantly higher in open surgery compared to laparoscopic surgery [17].

Ikeda *et al.* compared open and laparoscopic appendectomy in complicated and uncomplicated cases. The duration of laparoscopic surgery was longer than open appendectomy [18]. In contrast to the Ikeda *et al.* study,

we only included uncomplicated cases of appendicitis. There is some difference in results between studies done in this matter. In some studies, operation time in laparoscopic surgery was shorter than in open surgery. But in our study, the operation time of laparoscopy was significantly longer than open surgery. This difference may increase the immune response in our cases. Although the effect of sex may play a role in the immune response following surgery, it needs further studies for clarification. Our limitations in this study were to evaluate only CRP and the low sample number.

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