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Review

Surgical management of acute appendicitis in adults: A review of current techniques

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ABSTRACT

Acute appendicitis is one of the most frequent disorders in abdominal surgery. Therefore, appendectomy is a matter of significant interest in that field. Yet, four different techniques are available: open appendectomy, (conventional) laparoscopic appendectomy, single port laparoscopic appendectomy and NOTES-appendectomy with its different variations. To evaluate the current state of the art in appendectomy a bibliographic search was conducted. All prospectively randomized trials and national register cohort studies published between 1/2010 and 5/2016 were included into the analysis. Overall, 25 respective studies were identified. All studies were screened for the following parameters: surgical site infection (SSI) (wound infection (WI) or intraabdominal abscess (IAA)), postoperative pain (PP), length of surgery (LoS), length of hospital stay (LHS), return to normal activities (RNA). Today the rate of laparoscopic appendectomy is reported to be up to 86% in the recent literature. Open appendectomy remains a safe and effective technique. Single port laparoscopic appendectomy presented almost equal in terms of safety and patient satisfaction. The method is still not as widespread as conventional three port laparoscopic appendectomy, presumably due to the necessity of special equipment and training. NOTES appendectomy is the newest development in appendectomy technique. First prospective cohort studies proved the safety and feasibility in experienced hands. However, the method is still experimental and further prospectively randomized trials are necessary. Concluding the current evidence, a laparoscopic approach, which is most commonly and increasingly frequently used, could be called “state of the art” in the treatment of appendicitis.

1. Introduction

Appendectomy was first described by Mc Burney in 1894. After being introduced, it rapidly developed to one of the most common operations in abdominal surgery [1]. The method was used without technical changes for almost one century. In 1983, Kurt Semm, a German gynaecologist, performed the first laparoscopic appendectomy [2]. Hardly accepted in the beginning, the method was used with growing frequency in the following three decades. Meanwhile, laparoscopic appendectomy is well established in the treatment of acute appendicitis. In Germany, LA rate increased from 47 to 86% between 2005 and 2009 [3]. This development could be supported by numerous international publications. Apart from open and standard laparoscopic approach, single incision laparoscopic surgery and NOTES procedures are concurrent techniques completing the technical variety of appendectomy.

The importance of the choice of the respective surgical technique is repeatedly discussed controversially concerning optimal patient treatment as well as for economic aspects [4, 5]. Advantages and disadvantages have been examined in an overwhelming number of studies. For best possible patient care and economically seen, it is of particular importance to define the optimal surgical treatment for appendectomy. This review analyzes the current evidence for different approaches within the last five years to identify a “state of the art” procedure for acute appendicitis.

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2. Material and method

2.1. Literature research

We carried out a bibliographic search in Medline/PubMed and Cochrane-Database. Search items were “appendectomy”, “laparoscopic appendectomy”, “open appendectomy”, “single port appendectomy”, “NOTES-appendectomy”. To provide the best scientific evidence, all randomized controlled trials (RCT) and population based national register studies published between 1/2010 and 5/2016 were included into the analysis. For NOTES-appendectomy, no RCT's were available. Therefore three prospective cohort studies and two register cohort studies were included. Retrospective studies and reviews were excluded. Overall, 25 studies were identified: 14 on open vs. laparoscopic appendectomy (8 RCTs, 6 national register cohort studies), 6 RCTs on single port laparoscopic appendectomy, five studies on NOTES-appendectomy (3 RCTs, 2 register cohort studies). All publications were analyzed for the following parameters: Surgical site infection (SSI) (wound infection (WI); intraabdominal abscess (IAA)), postoperative pain (PP), length of surgery (LoS), Length of hospital stay (LHS), Return to normal activities (RNA). Due to a lack of prospective and register data, retrospective studies were included for the cost analysis of OA and LA.

3. Laparoscopic appendectomy

3.1. Open vs. laparoscopic approach

In 2010, a Cochrane review compared open (OA) and laparoscopic appendectomy (LA). For diagnostic effects, laparoscopic appendectomy was identified to be superior to open approach. By usage of laparoscopy, the rate of negative appendectomy could be lowered. In comparison to unselected adults (RR 0.37; CI 0.13 to 1.01), this effect was stronger in fertile women (RR 0.20; CI 0.11 to 0.34). This benefit was most significant in fertile women. Wound infection, postoperative pain, time to regular bowel function, hospital stay and time to regular activities were significantly reduced in LA. The authors emphasized in that context, that differences are minor and by that only with slight clinical impact. Sauerland et al. concluded LA to be advantageous over OA. In their study, one of the disadvantages of LA was a higher rate of intraabdominal abscesses in the LA group (OR 1.87; CI 1.19 to 2.93). Duration of surgery was 10 min longer in LA than in OA (CI 6 to 15). LA leads to higher in-hospital but lower post hospital costs [5].

The frequency of laparoscopic approaches increased significantly in the last years. Data in Table 1 show the growing rate of LA over the last two decades. These data underline that LA is fully accepted for the treatment of appendicitis and the frequency of LA-use is not only equal but higher than OA in recent studies. In the German population in 2009, 86% of all appendectomies were performed laparoscopically [6].

Between 2011 and 2016, eight prospectively randomized controlled trials (RCT) and six national register studies were identified which directly compared open and laparoscopic appendectomy. All publications were analyzed for the above mentioned parameters (Tables 2 and 3).

Table 1
Trends to laparoscopic appendectomy.

Author	Year	Rate of LA (%)	Year	Rate of LA (%)
Bliss	2003	41.7	2011	80.1
Andersson	1992	3.8	2009	32.9
Buia	2002	15	2008	40
Masoomi	2006	58.2	2008	72.0
Sahm	1996/1997	33.1	2008/2009	85.8

LA = laparoscopic appendectomy.

Table 2
RCT's - laparoscopic vs. open appendectomy.

Author	n	Technique (%)			SSI (%)			IAA (%)			PP (VAS)			LoS (min)			LHS (d)			RNA (d)			NA (%)		
		OA	LA	CO	OA	LA	p	OA	LA	p	OA	LA	p	OA	LA	p	OA	LA	p	OA	LA	p	OA	LA	p
Mantoglu, 2015	63	50.8	49.2	n.a.	0	6,5	0.05	0	6,5	0.05	2.78	**1.61**	**0.0001**	46.25	41.42	0.386	1.5	1.4	0.256	8.06	**5.06**	**0.0001**	n.a.	n.a.	n.a.
Ciftci, 2015	243	49.8	50.2	n.a.	4.1	0.8	n.a.	2.5	3.3	n.a.	7.6	7.1	**0.001**	50.9	51.0	0.884	28.92*	25.61*	0.071	5	4	n.a.	14.8	**6.5**	**0.009**
Taguchi, 2015	81	48.1	51.9	2.38	7.7	19.0	0.197	17.9	19.0	1.000	n.a.	n.a.	n.a.	63.5	84.6	**0.001**	11.9	11.4	0.838	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Thomson, 2014	112	46.4	53,6	7.0	21.4	5.1	0.03	2.4	11.8	0.16	n.a.	n.a.	n.a.	58.4	75.8	0.08	4.5	5	0.26	n.a.	n.a.	n.a.	7.7	13.3	n.a.
Kocatas, 2013	96	47.9	52.1	n.a.	6	2.1	0.618	2	2.1	0.999	9	8.78	0.537	n.a.	n.a.	n.a.	21.1*	20.3	0.618	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Tzovaras, 2010	147	51.0	49.0	22.2	5.3	2.8	n.s.	0	2.8	n.s.	n.a.	n.a.	n.a.	45	60	**0.0027**	2	2	n.s.	7	6	n.s.	n.a.	n.a.	n.a.
Wei, 2010	220	49.1	59.9	0	13	0	**< 0.05**	8.3	1.8	**< 0.05**	n.a.	n.a.	n.a.	28.7	30	> 0.05	7.2	4.1	**< 0.05**	13.7	9.1	**< 0.05**	n.a.	n.a.	n.a.
Kouhia, 2010	99	52.5	47.5	6.4	11.5	2.1	**0.005**	1.9	4.25	0.999	n.a.	n.a.	n.a.	38	**65**	**0.001**	1.5	1.5	0.789	13	8	**0.013**	27.0	25.5	n.a.

na = not analyzed; n.s. = not significant different; ua = uncomplicated appendicitis, ca = complicated appendiciitis, OA = Open appendectomy, LA = laparoscopic appendectomy, CO = conversion, SSI = surgical site infection; IAA = intraabdominal abscess, PP = postoperative pain; LoS = length of surgery; LHS = length of hospital stay, RNA = return to normal activities, NA = negative appendectomy, ex = excluded.
Significant results are highlighted bold.
*hours.