1 Advantages of Minimally Invasive Surgery in Upper Abdominal Surgery

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The postoperative advantages of the Minimally Invasive Surgical (MIS) approach in comparison with Open approach in Upper Gastrointestinal Oncology concern: (1) The stress and immune responses, (2) the surgical intervention, (3) the postoperative short-term effects and morbidity, (4) the postoperative Quality of Life and (5) the oncological consequences.

1.1 Advantages Holding for Stress and Immune Responses

All surgical traumas are followed by unanticipated side effects such as pain and infection. A theory regarding the onset of these side effects pertains to the surgical stress response entailing subsequently increased demands on the patient's reserves and immune status. The demand on organ functions is increased following surgery and it is thought to be mediated by trauma-induced endocrine and metabolic changes. To circumvent this problem and reduce surgical trauma, the first minimally invasive colectomy was described by Jacobs et al. in 1991 [1]. Since, many studies have shown the clinical short-term benefits for laparoscopic colectomy over open procedures without compromising oncological outcomes [2–5].

HLA-DR expression on monocytes is correlated to the competence of a patient's specific immune response. C-reactive protein levels are associated with postoperative infectious complications. Interleukin-6 levels are associated with postoperative complications rates and are a predictor of morbidity following surgical intervention. Since the introduction of laparoscopic colectomies, several studies have studied these parameters and compared the postoperative stress response between open and minimally invasive procedures. Wu et al. [6] and Harmon et al. [7] both described lower interleukin-6 levels following laparoscopic colectomy.

Both interleukin-6 levels and C-reactive protein levels were found to be lower for laparoscopic colectomies by Schwenk et al. [8]. Recently, our Department published a series of 40 patients comparing surgical stress response between laparoscopic and open total mesorectal excision (TME) [9]. Only a significant reduction in surgical stress response regarding HLA-DR expression in monocytes and interleukin-6 levels could be found for the laparoscopic TME at 2 h postoperatively. No differences regarding leukocytes, monocytes, C-reactive protein, interleukin-8, cortisol, growth hormone, and prolactin could be found at 24 h and 72 h postoperatively.

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The conclusion being that only a short-term benefit in surgical stress response for laparoscopic TME procedures could be proven. A similar outcome can be expected after Minimally Upper Abdominal Surgery.

The recent introduction of fast-track postoperative care by Kehlet [10–12] has revived the discussion regarding postoperative immune and stress response. Since the introduction of the fast-track multimodality postoperative care, no studies had yet appeared that investigated the stress response and immune function between fast-track and conventional care. Therefore, two surgical departments in Amsterdam, the AMC and the Vumc, conducted a randomized trial as substudy of the LAFA trial [13] comparing open versus laparoscopic colectomy with fast-track or conventional postoperative care [14]. Patients with nonmetastasized colon cancer were randomized to laparoscopic or open colectomy with fast-track or standard care. A significant difference in HLA-DR expression on monocytes (and therefore immune competence) was observed between the four groups (Fig. 1.1). Patient with laparoscopy and fast-track perioperative care remained the best immune-competent. Patients with open surgery and standard care were found to have higher postoperative C-reactive protein and IL-6 levels when compared to the other groups (Fig. 1.2). Laparoscopy seemed to better preserve immune status and reduce postoperative surgical trauma. On the other hand, in the present study, no clinical benefits such as less postoperative complications could be found.

The ensuing discussion concerns why laparoscopy and fast-track surgery has clinical advantages. Up to date, little evidence exists regarding a reduced-postoperative-surgical stress response explaining enhanced patient-recovery following laparoscopic colorectal surgery with or without fast-track perioperative care.

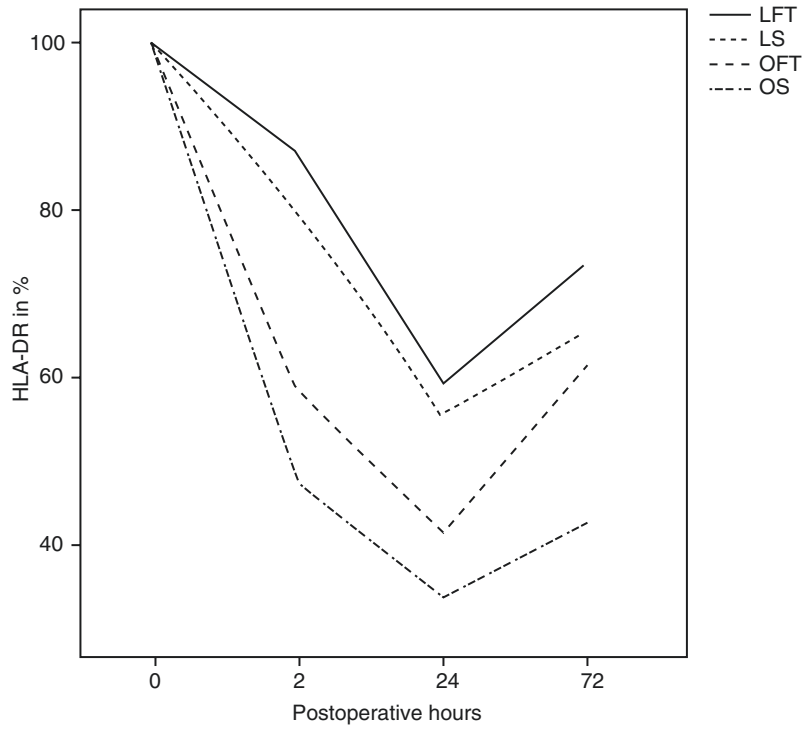

Fig. 1.1 Significant difference in HLA-DR expression on monocytes between the four groups studied in the LAFA trial. The two laparoscopic groups have a higher expression then the two open groups

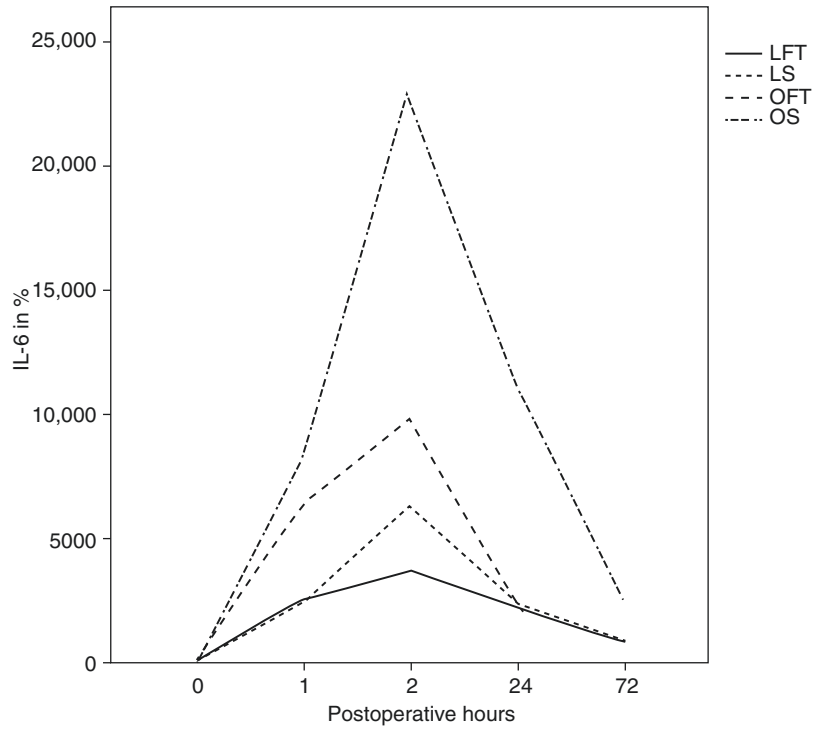

Fig. 1.2 Patients with open surgery and standard care of the LAFA trial have higher postoperative IL-6 levels when compared with the other three groups

1.2 Advantages of the MIS During Surgical Intervention

The advantages derived from the better visualization and the magnification obtained by the laparoscopic camera's are clear. Improvement in 2D-visualization obtained by high definition technologies has been very important in order to increase the quality of MIS and expand these operative techniques worldwide. If you can see better, you can probably dissect better. Moreover, the improvements produced by more advanced techniques—such as 3D-imaging and robot-assisted interventions—are very important but must be evidenced by randomized control studies before their global implementation. In the last 10 years, these imaging improvements have been sustained by new dissection instruments, sealing devices and staplers, which changed the way to operate involving important consequences such as less blood loss, more efficient dissection and new operative protocols. Furthermore, imaging diagnosis has been enormously improved, thereby permitting a better selection of patients and procedures. Hence, surgical anatomy is to be newly described according to the information generated by MIS. These changes will help to define more clearly the surgical planes to be dissected during oncological procedures, and so enhance standardizing the oncological resections [15].

1.3 Advantages on Postoperative Short-Term Effects, Including Morbidity

Short-term advantages of MIS in Upper GI and HPB Surgery are derived from the reduced amount of operative trauma. Advantages of MIS such as less morbidity, short hospital stay and a quicker recovery are frequently found. The reasons for the lower complication rate after MIS as compared to the procedure of its open coun-

terpart are multiple: (a) A careful dissection technique, (b) less blood loss, (c) avoidance of huge-approach wounds such as laparotomy or thoracotomy, and (d) the systematic dissection by planes.

Regarding MI esophagectomy, the published randomized control trial, i.e. the TIME trial, compared open esophagectomy (OE) with Total minimally invasive esophagectomy (MIE). The results demonstrated that MIE results in less blood loss, a lower incidence of pulmonary infections, a shorter hospital stay, and a better short-term quality of life without compromise of the quality of the resected specimen [16]. Concerning gastrectomy, there is evidence that the Minimally Invasive Gastrectomy is a feasible and acceptable surgical technique with short term advantages for partial gastrectomy whereas for total gastrectomy it should still be validated [17].

Laparoscopic total and partial gastrectomy in comparison with the open counterparts for gastric cancer are associated with a longer operative time but lower blood loss, with shorter postoperative hospital stay and faster postoperative recovery. Moreover, there were similar outcomes between both approaches in terms of completeness of the specimen and number of dissected lymph nodes and long-term follow-up (survival).

In Asian countries, the majority of studies (the KLASS studies) refer to a partial gastrectomy. These studies show better short-term outcomes for the minimally invasive approach. For total gastrectomy, hard evidence is lacking and outcomes are based on retrospective databases.

In the Netherlands, two CRTs compare laparoscopic and open gastrectomy: the STOMACH and the LOGICA trial; the STOMACH trial exclusively focused on total gastrectomy. The results of these trials will give more insight into evidence whether minimally invasive gastrectomy is as feasible and safe when performed in the West as it is in the East relating to the treatment of gastric cancer patients [18–22].

Concerning minimally invasive pancreatic surgery, it is demonstrated that for distal pancreatectomy it serves as the standard intervention. The problem involved is to standardize and demonstrate that MI duodenopancreatectomy (LPD) is equal or better than the open procedure. Holding for selected patients, when operated on by expert laparoscopic pancreatic surgeons, LPD seems feasible and safe. Pragmatic and multicenter randomized-control trials will have to demonstrate the superiority of minimally invasive pancreatoduodenectomy (LEOPARD trial). Regarding this operation, it is expected that the robot will give this technique a new and definitive impulse [23–28].

1.4 Consequences for Quality of Life

There is almost no evidence from Quality of Life (QoL) studies pertaining to the Upper GI surgery.

In the TIME trial comparing MIE and OE, QoL questionnaires showed that diverse components concerning physical scores are better-preserved postoperatively in the MIE group in comparison with the open group, and this favourable score remains 1-year postoperatively in favour of MIE. This advantage can be only explained by the avoidance of thoracotomy and the post-thoracotomy syndrome. Such QoL studies should in the future be implemented in every RCT [16, 30].

1.5 Are There Oncological Advantages of the MIS?

All RCT comparing MIS with open colectomies for colorectal cancer have found no differences in overall and disease-free survival and recurrences between the two approaches with the exception of the Barcelona trial for stage 3 colon cancer [2, 29]. Concerning the TIME trial, no differences in overall and disease free survival have been found between the two groups at 1 and 3 years follow-up [30]. Moreover, it seems that CRT and meta-analysis on partial gastrectomies have found no differences in quality of specimen resected and survival, but more evidence concerning survival and the quality of the specimens resected in total gastrectomy is necessary [18, 21, 22].

Pointedly, concerning duodenopancreatectomy and hepatic resections, studies are still ongoing in order to gain evidence that these minimally invasive procedures are oncologically safe [28, 31, 32].

Conclusion

There are potentially rather important advantages to be derived from the implementation of MIS in Upper abdominal surgery. Many advantages stem from reduced operative trauma and the magnificent visualization and magnification obtained. Additionally, acquisition of new instruments has changed the form of dissection and resection. Furthermore, meta-analysis shows that the short-term advantages obtained by MIS in upper abdominal surgery are the same as those produced by the laparoscopic colorectal surgery. These concern less morbidity, shorter hospital stay, faster postoperative recovery and better quality of life. Moreover, completeness of the resection and lymph nodes resected are similar for both procedures. The question remains about long-term oncological safety and survival. Probably, using MIS will by its better visualization and magnification and its dissection through the surgical planes, lead to more radical R0 interventions. Teaching programs designed for this complicated upper abdominal surgery are paramount for obtaining and extending the promising advantages of this approach for all patients.

References

1. Jacobs M, Verdeja JC, Goldstein HS. Minimally invasive colon resection (laparoscopic colectomy). Surg Laparosc Endosc. 1991;1:144–50.
2. Lacy AM, Garcia Valdecasas JC, Delgado S, et al. Laparoscopic-assisted colectomy versus open colectomy for treatment of non metastatic colon cancer: a randomised trial. Lancet. 2002;359:2224–9.
3. Nelson H, Sargent DJ, Wieand S, et al. A comparison of laparoscopically assisted and open colectomy for colon cancer. N Engl J Med. 2004;350:2050–9.
4. The COLOR cancer laparoscopic or Open Resection Study Group. Laparoscopic surgery versus open surgery for colon cancer: short term outcomes of a randomized trial. Lancet Oncol. 2005;6:477–84.
5. Weeks JC, Nelson H, Gelber S, et al. Short term quality-of-life outcomes following laparoscopic assisted vs. open colectomy for colon cancer: a randomised trial. JAMA. 2002;287:321–8.
6. Wu FPK, Sietses C, von Blomberg BME, et al. Systemic and peritoneal inflammatory response after laparoscopic or conventional colon resection in cancer patients: a prospective, randomised trial. Dis Colon Rectum. 2003;46:147–55.
7. Harmon GD, Senagore AJ, Kilbride MJ, Warzynski MJ. Interleukin-6 response to laparoscopic and open colectomy. Dis Colon Rectum. 1994;37:754–9.
8. Schwenk W, Jacobi C, Mansmann U, et al. Inflammatory response after laparoscopic and conventional colorectal resections-results of a prospective randomized trial. Langebecks Arch Surg. 2000;385:2–9.
9. Veenhof AA, Sietses C, von Blomberg BM, et al. The surgical stress response and postoperative immune function after laparoscopic or conventional total mesorectal excision in rectal acncer: a randomized trial. Int J Color Dis. 2011;26:53–9.
10. Wilmore DW, Kehlet H. Management of patients in fast track surgery. BMJ. 2001;322:473–6.
11. Kehlet H. Fast track colorectal surgery. Lancet. 2008;371:791–3.
12. Kehlet H, Wilmore DW. Evidence based surgical care and evolution of fast-track surgery. Ann Surg. 2008;248:189–98.
13. Vlug MS, Wind J, Hollemann MW, et al. Laparoscopy in combination with fast track multimodal management is the best perioperative strategy in patients undergoing colonic surgery: a randomized clinical trial (LAFA study). Ann Surg. 2011;254:868–75.
14. Veenhof AA, Vlug MS, vd Pas MH, et al. Surgical stress response and postoperative immune function after laparoscopy or open surgery with fast track or standard perioperative care: a randomized trial. Ann Surg. 2012;255:216–21.
15. Cuesta MA, Weijs TJ, Bleys RL, van Hillegersberg R, van Berge Henegouwen MI, Gisbertz SS, Ruurda JP, Straatman J, Osugi H, van der Peet DL. A new concept of the anatomy of the thoracic oesophagus: the meso-oesophagus. Observational study during thoracoscopic esophagectomy. Surg Endosc. 2015;29:2576–82.
16. Biere SSAY, van Berge Henegouwen MI, Maas KW, Bonavina L, Rosman C, Roig Garcia J, Gisbertz SS, Klinkenbijl JHG, Hollemann MW, de Lange ESM, Bonjer HJ, van der Peet DL, Cuesta MA. Minimally invasive versus open oesophagectomy for patients with oesophageal cancer: a multicentre, open-label, randomised control trial. Lancet. 2012;379:1887–92.
17. Huscher CGS, Mingoli A, Sgarzini G, Sansonetti A, Di Paola M, Recher A, Ponzano C. Laparosocpic versus open subtotal gastrectomy for distal gastric cancer. Five year results of a randomized prospective trial. Ann Surg. 2005;241(1):232–7.
18. Kim W, Kim HH, Han SU, Kim MC, Hyung WJ, Ryu SW, et al. Decreased morbidity of laparoscopic distal

gastrectomy compared with open distal gastrectomy for stage I gastric cancer: short-term outcomes from a multicenter randomized controlled trial (KLASS-01). Ann Surg. 2016;263(1):28–35.
19. Straatman J, van der Wielen N, Cuesta MA, de Lange-de Klerk ES, Jansma EP, van der Peet DL. Minimally invasive versus open total gastrectomy for gastric cancer: a systematic review and meta-analysis of short-term outcomes and completeness of resection: surgical techniques in gastric cancer. World J Surg. 2016;40:148–57.
20. Martínez-Ramos D, Miralles-Tena JM, Cuesta MA, Escrig-Sos J, van der Peet DL, Hoashi JS, Salvador-Sanchis JL. Laparoscopy versus open surgery for advances and resectable gastric cancer: a meta-analysis. Rev Esp Enferm Dig. 2011;103(3):133–41.
21. Straatman J, van der Wielen N, Cuesta MA, Gisbertz SS, Hartemink KJ, Alonso Poza A, Weitz J, Mateo Vallejo F, Akhtar K, Diez del Val I, Roig Garcia J, van der Peet DL. Surgical techniques, open versus minimally invasive gastrectomy after chemotherapy (STOMACH trial): study protocol for a randomized controlled trial. Trials. 2015;16:123.
22. Haverkamp L, Brenkman HJF, Seesing MFJ, Gisbert SS, van Berge Henegouwen MI, Luyer MDP, Nieuwenhuijzen GAP, Wijnhoven BPL, van Lanschot JJB, de Steur WO, Hartgrink HH, Stoot JHMB, Hulsewé KWE, Spillenaar Bilgen EJ, Rütter JE, Kouwenhoven EA, van Det MJ, van der Peet DL, Daams F, Draaisma WA, Broeders IAMJ, van Stel HF, Lacle MM, Ruurda JP, van Hillegersberg R. Laparoscopic versus open gastrectomy for gastric cancer, a multicenter prospectively randomized controlled trial (LOGICA trial). BMC Cancer. 2015;15:556.
23. Qin H, Qiu J, Zhao Y, Pan G, Zeng Y. Does minimally invasive pancreatoduodenectomy have advantages over its open method. A meta-analysis of retrospective studies. PLoS One. 2014;9(8):e104274.
24. Nakamura M, Nakashima H. Laparoscopic distal pancreatectomy and duodenopancreatectomy: is it worthwhile? J Hepatobiliary Pancreat Sci. 2013;20:421–8.
25. Boggi U, Ugo B, Gabriella A, Fabio V, Fabio C, De Lio N, Vittorio P, Linda B, Mario B, Stefano S, Franco M. Laparoscopic pancreaticoduodenectomy: a systematic literature review. Surg Endosc. 2014;29:9–23.
26. De Rooij T, Besselink M, Shamali A, Butturini G, Busch O, Troisi R, Fernández-Cruz L, Topal B, Dagher I, Bassi C, Abu Hilal M. Pan-European survey on laparoscopic pancreatic surgery. HPB (Oxford). 2016;18:e852–3.
27. Riviere D, Gurusamy KS, Kooby DA, et al. Laparoscopic versus open distal pancreatectomy for pancreatic cancer. Cochrane Database Syst Rev. 2016;4:CD011391. doi:10.1002/14651858.CD011391.pub2.
28. Pancreatic head and peri-ampullary cancer laparoscopic vs. open surgical treatment trial (PLOT). https://clinicaltrials.gov/ct2/show/NCT.
29. Bonjer HJ, Deijnen CL, Abis GA, et al. A randomized trial of laparoscopic versus open surgery for rectal cancer. N Engl J Med. 2015;372:1324–32.
30. Maas KW, Cuesta MA, van Berge Henegouwen MI, et al. Quality of life and late complications after minimally invasive compared to open esophagectomy. results of a randomized trial. World J Surg. 2015; 39:1986–93.
31. The ORANGE II plus trial. Open versus laparoscopic hemihepatectomy. Clinical trials gov. NCT01441856, RM van Dam, updated Sept 2016.
32. Chen J, Bai T, Zhang Y, et al. The safety and efficacy of laparoscopic and open hepatectomy in hepatocellular carcinoma patients with liver cirrhosis: a systematic review. J Clin Exp Med. 2015;8:20679–89.