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Extralevator versus standard abdominoperineal excision in locally advanced rectal cancer: a retrospective study with long-term follow-up

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Abstract:	Purpose To analyze the results of abdominoperineal excisions (APE) for locally advanced rectal cancer at our institution before and after the adoption of extralevator abdominoperineal excision (ELAPE) with a special reference to long-term survival. Methods A retrospective cohort study conducted in a tertiary referral center. All consecutive patients operated for locally advanced (TNM classification T3-4) rectal cancer with APE in 2004-2009 were compared to patients with similar tumours operated with ELAPE in 2009-2016. Results 42 ELAPE and 27 APE patients were included. Circumferential resection margin (CRM) was less than 1 mm (R1-resection) in 10 (24%) of ELAPE patients and 11 (41%) of APE patients (p=0.1358). Intraoperative perforation (IOP) occurred in 4 (10%) patients and 6 (22%) patients in ELAPE and APE groups, respectively (p=0.1336). There were 3 (7%) local recurrences (LRs) in ELAPE group and 5 (19%) in APE

	(p=0.2473). There were no statistical differences in adverse events, overall survival or disease free survival between ELAPE and APE groups. Conclusions We found a non-significant tendency to lower rates of IOP and positive CRM as well as lower rate of LR in the ELAPE group. Long-term survival and adverse events did not differ between the groups. ELAPE is beneficial for the surgeon in offering better vicinity to the perineal area and better work ergonomics. These technical aspects and the clinically very important tendency to lower rate of LR support the use of ELAPE technique in spite of the lack of survival benefit.
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Extralevator versus standard abdominoperineal excision in locally advanced rectal cancer: a retrospective study with long-term follow-up

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Abstract

Purpose

To analyze the results of abdominoperineal excisions (APE) for locally advanced rectal cancer at our institution before and after the adoption of extralevator abdominoperineal excision (ELAPE) with a special reference to long-term survival.

Methods

A retrospective cohort study conducted in a tertiary referral center. All consecutive patients operated for locally advanced (TNM classification T3-4) rectal cancer with APE in 2004-2009 were compared to patients with similar tumours operated with ELAPE in 2009-2016.

Results

42 ELAPE and 27 APE patients were included. Circumferential resection margin (CRM) was less than 1 mm (R1-resection) in 10 (24%) of ELAPE patients and 11 (41%) of APE patients (p=0.1358). Intraoperative perforation (IOP) occurred in 4 (10%) patients and 6 (22%) patients in ELAPE and APE groups, respectively (p=0.1336). There were 3 (7%) local recurrences (LRs) in ELAPE group and 5 (19%) in APE (p=0.2473). There were no statistical differences in adverse events, overall survival or disease free survival between ELAPE and APE groups.

Conclusions

We found a non-significant tendency to lower rates of IOP and positive CRM as well as lower rate of LR in the ELAPE group. Long-term survival and adverse events did not differ between the groups. ELAPE is beneficial for the surgeon in offering better vicinity to the perineal area and better work ergonomics. These technical aspects and the clinically very important tendency to lower rate of LR support the use of ELAPE technique in spite of the lack of survival benefit.

Introduction

Extralevator abdominoperineal excision (ELAPE) for the treatment of low rectal cancer was described by Holm in 2007 [1] taking the operation back to its roots as first introduced by Miles in 1908 [2]. The technique was advocated to overcome the problems encountered with standard abdominoperineal excision (APE), mainly positive circumferential resection margins (CRM) and intraoperative rectal perforations (IOP), which convened a worse oncological outcome when compared with patients treated with anterior resection [3-5]. Since then, ELAPE has become widely used, with some centers performing exclusively ELAPE [6,7] and others recommending the more radical approach only for selected cases with advanced tumours [8].

Two randomized controlled studies have been conducted comparing ELAPE and APE. Both showed a significantly reduced CRM positivity rate in ELAPE and Han et al also described lower rate of local recurrence (LR) after ELAPE [9,10]. Retrospective studies have shown lower IOP rates but also lower rates of positive CRM [11-15]. On the other hand, large registry and population based studies from Sweden, Denmark and Spain could not demonstrate any advantage of ELAPE over APE [16-18]. Even the results of published meta-analyses have been conflicting. Earlier studies show better CRM and lower IOP and LR rates after ELAPE [19-21] but the more recent meta-analyses with larger number of patients could only demonstrate reductions in IOP after ELAPE [22,23].

Even though the primary surgical results as assessed by CRM and IOP seem to be better after ELAPE than APE, none of the studies published so far have been able to show any survival benefit [7,8,24].

Resection of the levator muscles in ELAPE leads to a larger tissue defect and, thus, delayed healing of the perineal wound is common [17]. Perineal reconstruction is performed either with a myocutaneus flap or a biological mesh [1,25,26]. Perineal portion of ELAPE is usually performed with the patient in prone position. Turning the patient intraoperatively into the prone position and reconstructing the pelvic floor after extensive excision lead to increased operative times in ELAPE when compared to APE [17,27].

In Finland, the majority of abdominoperineal excisions are still performed in the standard way. For example in 2014 there were 159 APE and 61 ELAPE procedures [28]. In Turku University Hospital, ELAPE has been used since 2009 in patients with threatened CRM. As the superiority of ELAPE when compared to APE is controversial even in the recent literature, further studies on this issue are needed.

The primary aim of the present study was to determine whether patients operated with ELAPE have better long-term survival when compared to patients operated with APE. The secondary aims were to compare IOPs, CRMs and LRs in these patient groups and to determine whether the more extensive ELAPE operation increases morbidity.

Methods

Year 2004 marked the beginning of multidisciplinary team (MDT) meetings and the centralization of rectal cancer surgery in the catchment area of our university hospital. This was therefore selected as the starting point of our retrospective study. ELAPE was adopted at our institution in September 2009. From the beginning, this new technique was selectively used for patients with locally advanced T3-T4 tumours in which the CRM would have been threatened using the traditional APE. Patients received neoadjuvant chemoradiotherapy when feasible as recommended by the ESMO guidelines [29]. ELAPE was performed as described by Shibab et al. [30]. Perineal reconstruction was done using a biological mesh. All patients were operated on by experienced colorectal consultant surgeons within the centralized colorectal unit of Turku University Hospital. During the study period, postoperative adjuvant chemotherapy was generally recommended by our MDT meeting for locally advanced or node-positive rectal cancer.

All patients who underwent ELAPE for rectal adenocarcinoma between September 2009 and April 2016 were collected from the hospital's electronic patient records. Operations for locally recurrent rectal cancer were excluded.

To form a comparison group we included earlier patients who on the basis of imaging studies and clinical assessment would have been operated by ELAPE if the technique had already been in use. Therefore, we collected all patients who underwent APE between January 2004 and August 2009 and excluded patients with T1-T2 tumours and patients with mobile T3 tumours in which only short-term radiation therapy was given before the operation.

Patient records of eligible patients were reviewed and data on preoperative demographic information, operative details, tumour characteristics and postoperative recovery was collected. Adverse events were classified according to Clavien and Dindo [31]. Special attention was paid to the healing of the perineal wound. To assess specifically the survival effect of ELAPE versus APE, we omitted the patients with primarily metastatic disease from our survival analyses. Disease free survival (DFS) was calculated from the date of operation

to the date of diagnosis of metastatic or locally recurrent disease. Overall survival (OS) was calculated from the date of diagnosis to death of any cause.

The difference between the groups with regard to the distribution of baseline characteristics was analyzed for categorical variables by cross-tabulation and significances were tested with Pearson's chi-square test, or, in the case of small frequencies, with Fisher's exact test. For continuous variables the difference was analyzed by t-test for independent samples, or, for non-normally distributed continuous variables by Wilcoxon two sample test. The difference between groups in overall and disease free survival was studied by survival analysis, survival curves produced by Kaplan-Meier method and tested by Log-Rank test. Age and adjuvant treatment adjusted survival analyses were performed using the Cox proportional hazards model. Statistical analyses were done using SAS for Windows version 9.4. P-values below 0.05 were considered statistically significant.

Research permission was obtained from the Institutional Review Board of Turku University Hospital. For a retrospective registry study, no ethical approval was required according to Finnish legislation.

Results

There were 42 eligible patients in ELAPE and 27 in APE group (Table 1). Patients in the ELAPE group were slightly younger and in better general condition, as assessed by the American Society of Anesthesiologists (ASA) score. Three patients in the ELAPE group and two in the APE group did not receive preoperative radiotherapy. One patient in the ELAPE group was preoperatively assessed to have a T2 rectal cancer not requiring radiotherapy, for him the choice of ELAPE was made because of obesity, prominent buttocks and anterior tumour location. For the remaining four patients, the reasons for omission of radiotherapy were earlier pelvic radiotherapy for prostate cancer (3 patients) and age/comorbidities (1 patient).

Operative details are presented in Table 2. Laparoscopic approach was increasingly used from 2010 onwards. ELAPE operations were longer in duration but resulted in significantly less bleeding and thus fewer perioperative blood transfusions.

The distributions of ypTNM and stage were similar in the ELAPE and APE groups (Table 3). Patients with complete response after chemoradiotherapy were classified as ypT0 and stage 0. The proportions of positive CRM and IOP were smaller in the ELAPE group but the differences did not reach statistical significance (Tables 2 and 3).

Clavien-Dindo grades of the study groups are presented in Table 4. The most common adverse event for both study groups was perineal wound dehiscence and/or infection. Although the wound problems seemed to be more common and longer in duration after ELAPE, the differences were not statistically significant. Poor healing of the perineal wound inhibited the use of postoperative adjuvant chemotherapy only for two patients (5%) in the ELAPE group and for one patient (4%) in the APE group (p=1.000). Larger amount of grade II adverse events in the APE group is explained by the more common use of perioperative blood transfusions. One patient in the ELAPE group developed a perineal hernia. Two patients in the ELAPE group and one patient in the APE group suffered from chronic perineal pain.

Three patients underwent reoperations in the ELAPE group. One patient was reoperated for repair of vaginal wound dehiscence and one for abdominal wound dehiscence. One patient was reoperated twice, first for postoperative bleeding from inferior mesenteric vein and later for necrosis of colostomy. In the APE group, one patient was reoperated for small bowel obstruction. There was one postoperative death in the ELAPE group: the patient was disoriented immediately after the operation and was diagnosed with a brain metastasis. Metastasectomy was performed but the patient did not recover and was never discharged from the hospital.

Postoperative adjuvant chemotherapy was given to 31 (74%) and 17 (63%) patients in the ELAPE and APE groups, respectively (*p*=0.3393). For 6 (14%) and 2 (7%) patients it was considered unnecessary by the MDT meeting. Old age and comorbidities inhibited the use of chemotherapy significantly more often in the APE group than in the ELAPE group [7 (26%) versus 1 patients (2%), p=0.0047].

Survival was assessed for the patients with primarily nonmetastatic disease to evaluate specifically the effect of operative technique (ELAPE) on survival. Thus, the patients with synchronous metastases were excluded. The mean follow-up times for the ELAPE and APE patients were 3.2 and 5.8 years, respectively. Overall survival and disease free survival are presented in Figures 1 and 2 as Kaplan-Meier curves. In statistical analyses, there were no differences between the two groups, even when adjusted for age and adjuvant treatment. There were 3 (7%) local recurrences in the ELAPE group and 5 (19%) in the APE group (p=0.2473).

Discussion and conclusions

In this study, we found no difference in the disease free survival or overall survival of patients operated by ELAPE or APE. This is in line with earlier studies [7,8,24]. The median follow-up time of the ELAPE patients was approximately three years, which is still rather short but sufficient as most colorectal cancer recurrences are detected within the first three years of surveillance [32]. The survival rates were similar even though the patients in the APE group were older and had more comorbidity. According to the current study, it seems that the ELAPE technique offers no survival benefit for the patient when compared to APE.

Although the numbers of IOPs and CRM positivity seemed to be lower in the ELAPE group, the differences were not statistically significant. The IOP and CRM positivity rates were rather high in both groups, which reflects the advanced stage of the tumours. The proportions of patients in the ELAPE group with IOP (10%) and positive CRM (24%) were similar to those published recently by professor Holm's group (IOP 10%, positive CRM 20%) [33]. Their study included patients with similar tumours as ours, as the majority of patients had T3-T4 tumours. On the other hand for example in the randomized controlled trial of Bianco et al [9] who reported a significantly reduced rate of positive CRM (ELAPE 6%, APE 41%), the majority of the patients in the ELAPE group had T1-T2 tumours after chemoradiotherapy. In the population based studies which did not find any advantage of ELAPE over APE [16,17,18], the IOP rates have varied between 4-11% and CRM positivity between 6-16% with both operative techniques. Lower rates represent both the inclusion of more superficial tumours and the timeframe of the studies. With current attention to resection planes in abdominoperineal excision, the surgical results of standard APE have improved [18]. The historical comparison group is in this regard a limitation of the current study. Because all advanced tumours have been operated with ELAPE in our hospital since 2009, a contemporary comparison group with similar tumours could unfortunately not be collected.

LR was detected in 7% of the ELAPE patients vs. 19% of APE group, but the difference did not reach statistical significance. In literature, LR rates of 0-13% after ELAPE have been reported [10,11,12,16,34] and some studies have reached significant differences when compared to rates of LR after APE (15-19%) [7,10,12]. Similar difference has not been demonstrated in all studies, and some report LR rates as low as 3-9% after APE [16,34]. In clinical practice, the possible decrease in LR rate is very significant for the patients, as LR after abdominoperineal excision is often inoperable and can cause severe pelvic pain and persisting fistulae.

An important finding in the current study was that the tendency to prolonged healing of the perineal wound did not inhibit the use of postoperative adjuvant chemotherapy. In previous studies this outcome has not been reported. There were no statistical differences in the number and grade of adverse events, but as perineal wound healing problems are common (45% in ELAPE and 30 % in APE group), all patients receiving abdominoperineal excision should be informed preoperatively of the high likelihood of wound dehiscence, especially after neoadjuvant chemoradiotherapy.

Although the survival of our patients with advanced tumours was relatively high and the rate of LR tolerable, the rates of IOP and positive CRM were still rather high. It has recently been shown that especially for anterior tumours with threatened CRM, ELAPE does not increase the CRM compared to APE and that in these cases a pelvic exenteration might be more appropriate [35]. It has also been suggested that for tumours infiltrating the levator muscles, ischioanal fat or perianal skin, an ischioanal APE should be performed, extending the dissection even more laterally to include the fatty tissue around the sphincters [36]. Further research will be needed in the future to assess the benefits of these even more extensive procedures.

In addition to the historical comparison group, limitations of this study include its retrospective setting and relatively small sample size. For a single-center study, it would require a much longer time period to include more patients. On the other hand it is a strength of this study that all patients in both study groups have been operated in a single center by the same experienced surgeons during a time frame in which there were no significant changes in the adjuvant therapy regimes. All data were collected retrospectively, but from prospectively maintained electronic hospital records. Finnish cause of death records are also very precise and accurate, so survival analyses can be considered very reliable.

To conclude, this study could not demonstrate any survival benefit for patients operated by ELAPE when compared to APE. There was a tendency to lower rates of IOP and positive CRM as well as lower rate of LR in the ELAPE group, but the differences were not statistically significant. Clinical experience has shown that ELAPE is beneficial to the surgeon in offering better vicinity to the perineal area and better work ergonomics, especially when treating obese male patients. These technical aspects and the clinically very important tendency to lower rate of LR support the ongoing use of ELAPE technique in spite of the lack of survival benefit.

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Conflict of Interest

The authors declare that they have no conflict of interest.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. For this type of study formal consent is not required.

References

1. Holm T, Ljung A, Haggmark T, Jurell G, Lagergren J (2007) Extended abdominoperineal resection with gluteus maximus flap reconstruction of the pelvic floor for rectal cancer. Br J Surg 94 (2):232-238. doi:10.1002/bjs.5489
2. Miles WE (1908) A method of performing abdomino-perineal excision for carcinoma of the rectum and of the terminal portion of the pelvic colon. Lancet 2:1812-1813
3. Eriksen MT, Wibe A, Syse A, Haffner J, Wiig JN, Norwegian Rectal Cancer G, Norwegian Gastrointestinal Cancer G (2004) Inadvertent perforation during rectal cancer resection in Norway. Br J Surg 91 (2):210-216. doi:10.1002/bjs.4390
4. Wibe A, Syse A, Andersen E, Tretli S, Myrvold HE, Soreide O, Norwegian Rectal Cancer G (2004) Oncological outcomes after total mesorectal excision for cure for cancer of the lower rectum: anterior vs. abdominoperineal resection. Dis Colon Rectum 47 (1):48-58. doi:10.1007/s10350-003-0012-y
5. Nagtegaal ID, van de Velde CJ, Marijnen CA, van Krieken JH, Quirke P, Dutch Colorectal Cancer G, Pathology Review C (2005) Low rectal cancer: a call for a change of approach in abdominoperineal resection. J Clin Oncol 23 (36):9257-9264. doi:10.1200/JCO.2005.02.9231
6. Gravante G, Miah A, Mann CD, Stephenson JA, Gani MA, Sharpe D, Norwood M, Boyle K, Miller A, Hemingway D (2016) Circumferential resection margins and perineal complications after neoadjuvant long-course chemoradiotherapy followed by extralevator abdominoperineal excision of the rectum: Five years of activity at a single institution. J Surg Oncol 114 (1):86-90. doi:10.1002/jso.24257
7. Stelzner S, Hellmich G, Sims A, Kittner T, Puffer E, Zimmer J, Bleyl D, Witzigmann H (2016) Long-term outcome of extralevator abdominoperineal excision (ELAPE) for low rectal cancer. Int J Colorectal Dis 31 (10):1729-1737. doi:10.1007/s00384-016-2637-z
8. Prytz M, Angenete E, Bock D, Haglind E (2016) Extralevator Abdominoperineal Excision for Low Rectal Cancer--Extensive Surgery to Be Used With Discretion Based on 3-Year Local Recurrence Results: A Registry-based, Observational National Cohort Study. Ann Surg 263 (3):516-521. doi:10.1097/SLA.0000000000001237
9. Bianco F, Romano G, Tsarkov P, Stanojevic G, Shroyer K, Giuratrabocchetta S, Bergamaschi R, International Rectal Cancer Study G (2016) Extralevator with vertical rectus abdominis myocutaneous flap vs. non-extralevator abdominoperineal excision for rectal cancer: the RELAPe randomized controlled trial. Colorectal Dis. doi:10.1111/codi.13436
10. Han JG, Wang ZJ, Wei GH, Gao ZG, Yang Y, Zhao BC (2012) Randomized clinical trial of conventional versus cylindrical abdominoperineal resection for locally advanced lower rectal cancer. Am J Surg 204 (3):274-282. doi:10.1016/j.amjsurg.2012.05.001
11. Perdawood SK, Lund T (2015) Extralevator versus standard abdominoperineal excision for rectal cancer. Tech Coloproctol 19 (3):145-152. doi:10.1007/s10151-014-1243-8
12. Shen Z, Ye Y, Zhang X, Xie Q, Yin M, Yang X, Jiang K, Liang B, Wang S (2015) Prospective controlled study of the safety and oncological outcomes of ELAPE procure with definitive anatomic landmarks versus conventional APE for lower rectal cancer. Eur J Surg Oncol 41 (4):472-477. doi:10.1016/j.ejso.2015.01.017
13. West NP, Finan PJ, Anderin C, Lindholm J, Holm T, Quirke P (2008) Evidence of the oncologic superiority of cylindrical abdominoperineal excision for low rectal cancer. J Clin Oncol 26 (21):3517-3522. doi:10.1200/JCO.2007.14.5961
14. West NP, Anderin C, Smith KJ, Holm T, Quirke P, European Extralevator Abdominoperineal Excision Study G (2010) Multicentre experience with extralevator abdominoperineal excision for low rectal cancer. Br J Surg 97 (4):588-599. doi:10.1002/bjs.6916
15. Stelzner S, Hellmich G, Schubert C, Puffer E, Haroske G, Witzigmann H (2011) Short-term outcome of extra-levator abdominoperineal excision for rectal cancer. Int J Colorectal Dis 26 (7):919-925. doi:10.1007/s00384-011-1157-0

16. Ortiz H, Ciga MA, Armendariz P, Kreisler E, Codina-Cazador A, Gomez-Barbadillo J, Garcia-Granero E, Roig JV, Biondo S, Spanish Rectal Cancer P (2014) Multicentre propensity score-matched analysis of conventional versus extended abdominoperineal excision for low rectal cancer. Br J Surg 101 (7):874-882. doi:10.1002/bjs.9522
17. Prytz M, Angenete E, Ekelund J, Haglind E (2014) Extralevator abdominoperineal excision (ELAPE) for rectal cancer--short-term results from the Swedish Colorectal Cancer Registry. Selective use of ELAPE warranted. Int J Colorectal Dis 29 (8):981-987. doi:10.1007/s00384-014-1932-9
18. Klein M, Fischer A, Rosenberg J, Gogenur I, Danish Colorectal Cancer G (2015) Extralevatory abdominoperineal excision (ELAPE) does not result in reduced rate of tumor perforation or rate of positive circumferential resection margin: a nationwide database study. Ann Surg 261 (5):933-938. doi:10.1097/SLA.0000000000000910
19. Stelzner S, Koehler C, Stelzer J, Sims A, Witzigmann H (2011) Extended abdominoperineal excision vs. standard abdominoperineal excision in rectal cancer--a systematic overview. Int J Colorectal Dis 26 (10):1227-1240. doi:10.1007/s00384-011-1235-3
20. Yu HC, Peng H, He XS, Zhao RS (2014) Comparison of short- and long-term outcomes after extralevator abdominoperineal excision and standard abdominoperineal excision for rectal cancer: a systematic review and meta-analysis. Int J Colorectal Dis 29 (2):183-191. doi:10.1007/s00384-013-1793-7
21. De Nardi P, Summo V, Vignali A, Capretti G (2015) Standard versus extralevator abdominoperineal low rectal cancer excision outcomes: a systematic review and meta-analysis. Ann Surg Oncol 22 (9):2997-3006. doi:10.1245/s10434-015-4368-8
22. Negoi I, Hostiuc S, Paun S, Negoi RI, Beuran M (2016) Extralevator vs conventional abdominoperineal resection for rectal cancer-A systematic review and meta-analysis. Am J Surg 212 (3):511-526. doi:10.1016/j.amjsurg.2016.02.022
23. Zhou X, Sun T, Xie H, Zhang Y, Zeng H, Fu W (2015) Extralevator abdominoperineal excision for low rectal cancer: a systematic review and meta-analysis of the short-term outcome. Colorectal Dis 17 (6):474-481. doi:10.1111/codi.12921
24. Klein M, Colov E, Gogenur I (2016) Similar long-term overall and disease-free survival after conventional and extralevator abdominoperineal excision-a nationwide study. Int J Colorectal Dis 31 (7):1341-1347. doi:10.1007/s00384-016-2596-4
25. Jensen KK, Rashid L, Pilsgaard B, Moller P, Wille-Jorgensen P (2014) Pelvic floor reconstruction with a biological mesh after extralevator abdominoperineal excision leads to few perineal hernias and acceptable wound complication rates with minor movement limitations: single-centre experience including clinical examination and interview. Colorectal Dis 16 (3):192-197. doi:10.1111/codi.12492
26. Foster JD, Pathak S, Smart NJ, Branagan G, Longman RJ, Thomas MG, Francis N (2012) Reconstruction of the perineum following extralevator abdominoperineal excision for carcinoma of the lower rectum: a systematic review. Colorectal Dis 14 (9):1052-1059. doi:10.1111/j.1463-1318.2012.03169.x
27. Vaughan-Shaw PG, Cheung T, Knight JS, Nichols PH, Pilkington SA, Mirnezami AH (2012) A prospective case-control study of extralevator abdominoperineal excision (ELAPE) of the rectum versus conventional laparoscopic and open abdominoperineal excision: comparative analysis of short-term outcomes and quality of life. Tech Coloproctol 16 (5):355-362. doi:10.1007/s10151-012-0851-4
28. National Institute for Health and Welfare. Specialised somatic health care. Care periods in 2014. Finnish official statistics. Available in Finnish and Swedish at https://www.thl.fi/fi/tilastot/tilastot-aiheittain/erikoissairaanhoidon-palvelut/somaattinen-erikoissairaanhoito. Accessed 21st of March 2017.
29. Glimelius B, Tiret E, Cervantes A, Arnold D (2013) Rectal cancer: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. Ann Oncol 24 Suppl 6:vi81-88. doi:10.1093/annonc/mdt240

30. Shihab OC, Heald RJ, Holm T, How PD, Brown G, Quirke P, Moran BJ (2012) A pictorial description of extralevator abdominoperineal excision for low rectal cancer. Colorectal Dis 14 (10):e655-660. doi:10.1111/j.1463-1318.2012.03181.x
31. Dindo D, Demartines N, Clavien PA (2004) Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 240 (2):205-213
32. Baca B, Beart RW, Jr., Etzioni DA (2011) Surveillance after colorectal cancer resection: a systematic review. Dis Colon Rectum 54 (8):1036-1048. doi:10.1007/DCR.0b013e31820db364
33. Palmer G, Anderin C, Martling A, Holm T (2014) Local control and survival after extralevator abdominoperineal excision for locally advanced or low rectal cancer. Colorectal Dis 16 (7):527-532. doi:10.1111/codi.12610
34. Asplund D, Haglind E, Angenete E (2012) Outcome of extralevator abdominoperineal excision compared with standard surgery: results from a single centre. Colorectal Dis 14 (10):1191-1196. doi:10.1111/j.1463-1318.2012.02930.x
35. How P, West NP, Brown G (2014) An MRI-based assessment of standard and extralevator abdominoperineal excision specimens: time for a patient tailored approach? Ann Surg Oncol 21 (3):822-828. doi:10.1245/s10434-013-3378-7
36. Holm T (2014) Controversies in abdominoperineal excision. Surg Oncol Clin N Am 23 (1):93-111. doi:10.1016/j.soc.2013.09.005

Table 1: **Demografic and preoperative chracteristics**

	ELAPE (n = 42)	APE (n = 27)	*P*
Age, years	61 (2)	67 (2)	**0.0322**
BMI, kg/m²	26 (1)	27 (1)	0.2269
Gender (F/M)	1:1.8	1:2.9	0.3945
Smokers	9 (21)	11 (41)	0.0844
History of diabetes mellitus	4 (10)	7 (26)	0.0709
ASA score			**0.0037**
ASA I	4 (10)	0 (0)	
ASA II	24 (57)	8 (30)	
ASA III	13 (31)	13 (48)	
ASA IV	1 (2)	6 (22)	
Preoperative clinical T stage			1.0000
T2	1 (2)	0 (0)	
T3	23 (55)	15 (56)	
T4	18 (43)	12 (44)	
Preoperative CEA, µg/l	4.6 (2.5-8.9)	6.5 (3.4-12.0)	0.2481
Preoperative radiotherapy			
No radiotherapy	3 (7)	2 (7)	0.6554
Short 5 x 5 Gy	11 (26)	0 (0)	**0.0023**
Long 50.4 Gy without chemotherapy	0 (0)	6 (22)	**0.0025**
Long 50.4 Gy with capecitabine	28 (67)	19 (70)	0.7473

Values are given as mean (SEM), ratio, n (%) or median (interquartile range).
ASA, American Society of Anesthesiology; BMI, body mass index; ELAPE, extralevator abdominoperineal excision; APE, standard abdominoperineal excision; F/M, female/male ratio.

Table 2: Operative details

	ELAPE (n = 42)	APE (n = 27)	*P*
Surgical access in abdominal phase			**<0.0001**
Open	24 (57)	27 (100)	
Laparoscopic	18 (43)	0 (0)	
Operative time, min	237 (6)	166 (9)	**<0.0001**
Blood loss, ml	442 (42)	1067 (178)	**0.0019**
Blood transfusion perioperatively	10 (24)	17 (63)	**0.0011**
IOP	4 (10)	6 (22)	0.1336

Values are given as n (%) or mean (SEM).
ELAPE, extralevator abdominoperineal excision; APE, standard abdominoperineal excision; IOP, intraoperative perforation.

Table 3: Histopathological classification and findings

	ELAPE (n = 42)	APE (n = 27)	*P*
ypT staging			0.6169
pT0	4 (10)	1 (4)	
pT1	2 (5)	1 (4)	
pT2	6 (14)	4 (15)	
pT3	20 (48)	14 (52)	
pT4a	3 (7)	3 (11)	
pT4b	7 (17)	4 (15)	
ypN staging			0.8172
N0	26 (62)	16 (59)	
N1a	6 (14)	2 (7)	
N1b	1 (2)	5 (19)	
N2a	5 (12)	1 (4)	
N2b	4 (10)	3 (11)	
ypM staging			0.1554
M0	36 (86)	26 (96)	
M1a	4 (10)	1 (4)	
M1b	2 (5)	0 (0)	
Stage			0.7343
0	4 (10)	1 (4)	
I	5 (12)	2 (7)	
II	16 (38)	13 (48)	
III	11 (26)	10 (37)	
IV	6 (16)	1 (4)	
Number of nodes retrieved	14 (6)	12 (4)	0.1020
CRM involvement	10 (24)	11 (41)	0.1358
CRM, mm	4.8 (0.7)	3.6 (0.8)	0.2672

Values are given as n (%) or mean (SEM).

ELAPE, extralevator abdominoperineal excision; APE, standard abdominoperineal excision; CRM, circumferential resection margin.

Table 4: Adverse events

	ELAPE (n = 42)	APE (n = 27)	*P*
Clavien-Dindo grade			0.3574
0	12 (29)	6 (22)	
I	7 (17)	0 (0)	
II	18 (43)	20 (74)	
IIIa	1 (2)	0 (0)	
IIIb	3 (7)	1 (4)	
IV	0 (0)	0 (0)	
V	1 (2)	0 (0)	
Perineal wound dehiscence and/or infection	19 (45)	8 (30)	0.1948
Time to healing of perineal wound, weeks	8.5 (1.92)	3.5 (1.44)	0.0731

Values are given as n (%) or mean (SEM).

ELAPE, extralevator abdominoperineal excision; APE, standard abdominoperineal excision.

Figure captions

Fig.1 Overall survival of patients in ELAPE (n = 36) and APE (n = 26) groups, p=0.8173. ELAPE, extralevator abdominoperineal excision; APE, standard abdominoperineal excision.

Fig.2 Disease free survival of patients in ELAPE (n = 36) and APE (n = 26) groups, p=0.6311. ELAPE, extralevator abdominoperineal excision; APE, standard abdominoperineal excision.

Figure 1

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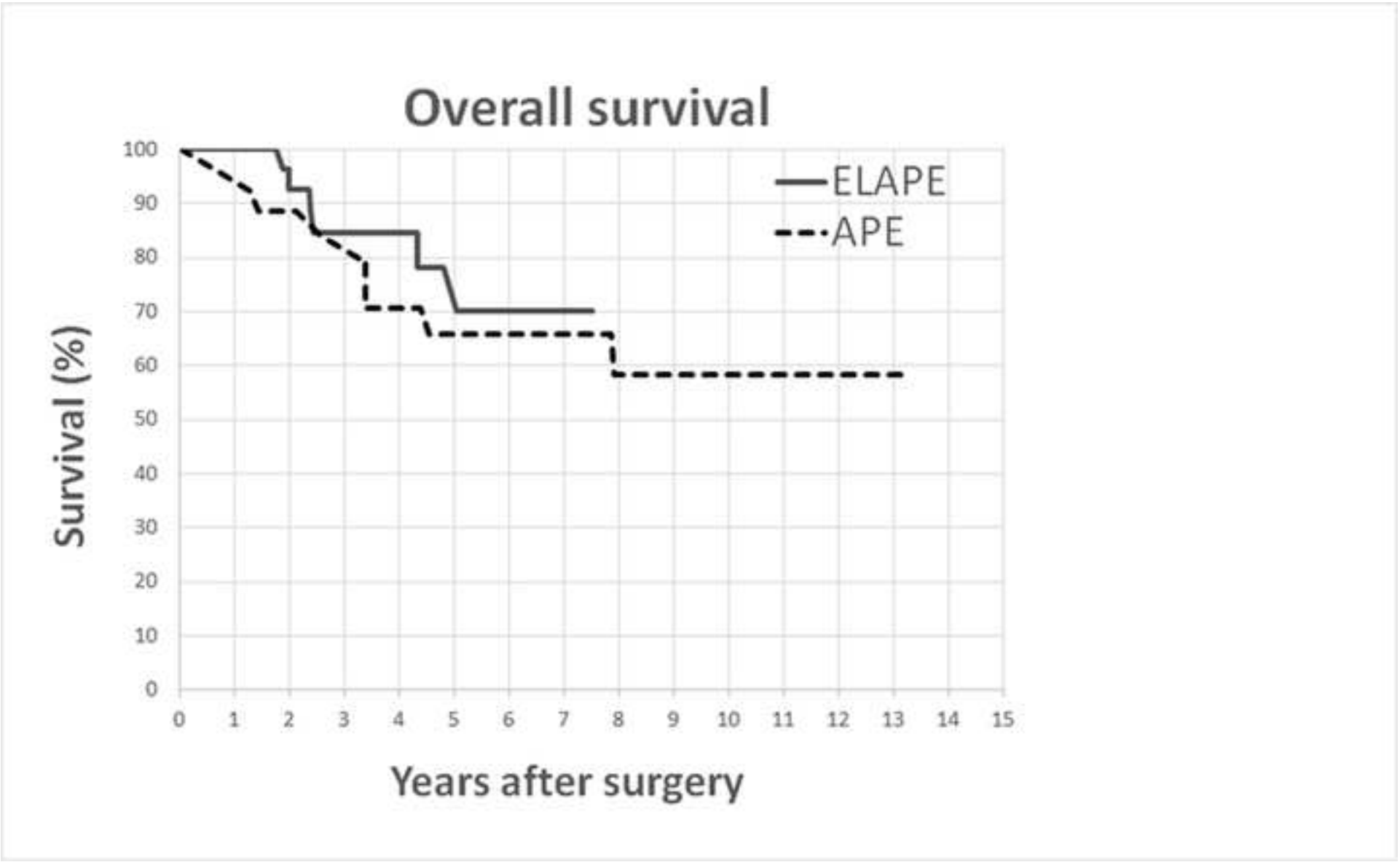

Figure 2

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