Systematic review on citation classics in minimally invasive gastrointestinal surgery.

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Review Article

Systematic review on citation classics in minimally invasive gastrointestinal surgery

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Abstract

Background: The impact an article has on a specific field is manifested by its number of citations. The aim of this systematic review was to perform a citation analysis and identify the 100 most-cited articles in the field of minimally invasive (MI) gastrointestinal (GI) surgery.

Methods: The Institute for Scientific Information Web of Knowledge (1945–2017) was utilised to identify the top 100 most-cited articles in the field of MI GI surgery, using 19 distinct keywords. The data extracted were number of citations, time of publication, research topic, level of evidence, authorship and country of origin.

Results: Of the 100 most-cited articles, the number of citations ranged from 3331 to 317 citations. Most publications reported on bariatric surgery (n = 36), followed by oncology (n = 26) and hepatobiliary surgery (n = 15). The studies were published in 26 different journals with the top three journals being Annals of Surgery (n = 30), New England Journal of Medicine (n = 10) and Obesity Surgery (n = 9). The studies were conducted in 17 different countries led by the USA (n = 51), the UK (n = 9) and France (n = 6). Articles were published on all levels of evidence: level I (n = 20), Level II (n = 29), Level III (n = 8), Level IV (n = 29) and Level V (n = 14).

Conclusion: The study revealed citation classics in the field of MI surgery. Interestingly, a high level of evidence was not significantly associated with an increased citation number.

Keywords: Bibliometric analysis, citation classics, laparoscopic surgery, minimally invasive surgery, most-cited articles

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INTRODUCTION

Surgery is a medical speciality defined by its authority to diagnose, prevent or cure illnesses by means of bodily invasion. Surgery was first developed to treat traumas and injuries. The oldest evidence-supported surgical procedure is trepanation. The procedure dates back 2300 years ago and involved drilling a hole in the human skull, exposing the dura mater to treat intracranial diseases and disorders.[1] Since then, surgeons have utilised their talents to develop more sophisticated surgical techniques. In the 10th century,

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an Arab doctor named Albukasim was among the first to examine body orifices through developing a speculum illuminated with candlelight and mirrors. This later formed the framework for laparoscopic surgery.[2] The first laparoscopic examination of the peritoneal cavity was attempted by George Kelling in 1901, and in 1987, Mouret performed the first laparoscopic cholecystectomy on a human.[3] Since then, the laparoscopic access has become the standard of care for several gastrointestinal (GI) surgeries as the reduced invasiveness results in less post-operative pain, faster recovery and less surgery-associated problems such as incisional hernias and adhesions in the long term.

Sir William Osler was the first to introduce the triple-treat concept of physicians expanding their knowledge through the work as clinicians but by also conducting research and teaching.[4] He once said, 'The higher the standard of education in a profession, the less marked will be the charlatanism'. Since then, the publication of evidence-based medicine has led to constantly improved treatments. The impact of a scientific publication on its specific field can be quantified by the number of citations. The Institute for Scientific Information Web of Knowledge is an online indexing and citation service; it covers articles published since 1945.[5] It is regarded as unique due to its ability to search in five different databases: Web of Science, Derwent Innovations Index, BIOSIS Previews and Journal Citation Reports. The objective of this systematic review is to convey a close inspection, of the 100 most-cited studies, in the field of minimally invasive (MI) GI surgery, to highlight leading-edge discoveries and promising areas of research as well as centres of excellence and competitive researchers specialised in the field.

METHODS

The reporting of this systematic review adheres to the PRISMA guidelines.[6]

Citation reports were provided for those articles, which were published in journals acknowledged by the Thomson Reuters Journal Citation Reports®. Articles' topic fields were searched for the following keywords: endoscopy, laparoscopy, minimally invasive, bariatric, gastric, gastrointestinal, hepatobiliary, robotic, cholecystectomy, hernia, appendectomy, reflux disease, splenectomy, pancreatectomy, resection, fundoplication, gastrectomy, esophagectomy, surgery (The keyword surgery is a broad far-reaching keyword that covers all surgery-related articles). The topic field included the title, abstract, author keywords and keywords within a record. Peer-reviewed open-access journals were also included in the search, with no language restrictions. The search was conducted in July 2017 and comprised all articles published since 1945. Article screening and data extraction were performed by two independent investigators. Any disagreement was resolved by consulting a third reviewer.

Eligibility criteria and the allocation of articles

Articles from all 19 subject categories mentioned above were pooled and sorted, in the descending order, based on the number of citations. The 100 most-cited articles were considered eligible if the following inclusion criteria were met: (1) articles where laparoscopic or robotic GI surgery was mentioned or utilised significantly. Excluded were articles referring to urology, gynaecology or reporting guidelines [Figure 1].

Data extraction

The following data were extracted from each of the top 100 most-cited articles: title, journal, year of publication, authorship (first and last author), department, institution and country where the study was conducted, field of research (bariatrics, hepatobiliary [HPB], hernia, upper GI, lower GI, oncology and everything else were classified as general), level of evidence (according to the Oxford Centre for Evidence-Based Medicine); article type (experimental article, original article, review article); classification (laboratory study, survey, clinical consensus, case report, case series, cohort, randomised controlled trials [RCT], systematic review), total number of citations, citation density (total number of citations/article age).

Statistical analysis

The descriptive and bivariate statistical analyses were performed using IBM SPSS Statistics, version 22.0. Armonk, NY, USA. Departures from normality were detected using the Shapiro–Wilk test. Depending on the normality and distribution of the data, the mean (standard deviation) or median (interquartile range) was used. Kruskal–Wallis test was used to determine if the difference between the median of two or more independent groups is statistically significant. *Post-hoc* testing was performed, when necessary, to test for significant difference between each of the

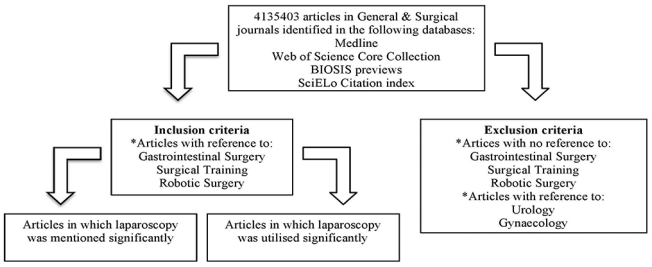

Figure 1: Flowchart illustrating article allocation

variables. The Mann-Kendall trend test was performed to test any increasing or decreasing time-dependent trends. The Spearman rank was used to determine and test for correlations between variables. A $P < 0.05$ was regarded as statistically significant.

RESULTS

The database identified 4,141,353 different articles, published in 100 journals. The 100 top-cited articles in MI GI surgery were included [Table 1]. The top-cited articles had 3331 citations, while the lowest stood at 317 citations. The articles were published in 1983–2014 [Figure 2]. The highest total number of citations was in the 2000s (69% of total citations) followed by 1990s (19% of total citations), 2010s (10% of total citations) and 1980s (2% of total citations). The included articles were published in 26 different journals with the top three journals being Annals of Surgery ($n = 30$), New England Journal of Medicine ($n = 10$) and Obesity Surgery ($n = 9$). Table 2 gives a detailed overview of all the 26 journals, in which the articles were published.

Research area

The most common research area was bariatric surgery ($n = 36$; 39% of the total number of citations), followed by oncology ($n = 27$; 27% of the total number of citations), HPB ($n = 15$; 14% of the total number of citations), general surgery ($n = 13$; 11% of the total number of citations), upper GI ($n = 5$; 6% of the total number of citations), hernia surgery ($n = 3$; 2% of the total number of citations) and lower GI ($n = 1$; 1% of the total number of citations).

Level of evidence

Articles were published on all levels of evidence. However, only 20% of the publications were of level evidence I [Table 3]. The total number of citations for each group of level of evidence did not vary significantly (correlation coefficient = 0.109, $P = 0.283$). On the other hand, the citation density (average number of citations per year) varied significantly among different levels of evidence (correlation coefficient = −0.222, $P = 0.026$).

Article type

Most of the top 100 most-cited articles were original articles (78/100), followed by review articles (20/100) and experimental articles (2/100). The difference in the median number of citations per article, between original articles 453 (range: 317–1613), review articles 395 (range: 319–3331) and experimental articles 558 (range: 515–602), was not statistically significant ($P = 0.145$). Most of the studies were RCTs ($n = 30$), followed by non-randomised case series ($n = 29$), systematic reviews ($n = 20$), cohort studies ($n = 7$), case reports ($n = 5$), surveys ($n = 5$), clinical consensus ($n = 2$) and laboratory studies ($n = 2$).

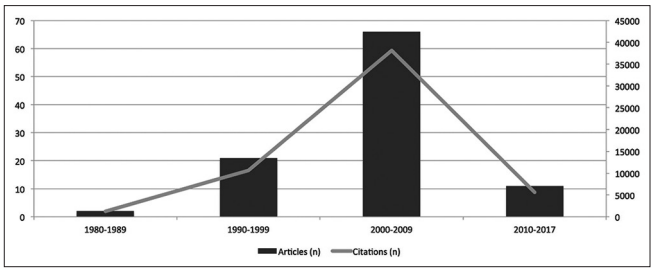

Figure 2: Publications per decade with number of citations per decade

Research institutions

The 100 most-cited articles originated from 17 different countries, namely the USA ($n = 51$), the UK ($n = 9$), France ($n = 6$), the Netherlands ($n = 6$), Australia, Belgium, Canada, Italy ($n = 4$ each), the Republic of Korea ($n = 3$), Japan ($n = 2$), Austria, Denmark, Germany, Greece, China, Spain and Sweden ($n = 1$ each). Most of the articles originated from surgical departments (80%). Research institutions with three or more publications were the Cleveland Clinic ($n = 7$), the University of Minnesota ($n = 6$), University of Pittsburgh, University of Washington ($n = 5$ each), Imperial College London, McGill University, St James's University Hospital and University of California ($n = 3$ each). Frequent authors (authors with more than one first or senior authorship) contributed to 37 of the 100 most-cited articles. There were nine frequent first authors and six frequent senior authors. Frequent authors showed no more than two research areas of interest. Buchwald had the highest number of publications ($n = 6$), followed by Schauer ($n = 4$). Both showed an interest in the field of bariatric surgery. The field of oncology was led by Kitano, Jayne and Brown (n = 2 each). HPB, on the other hand, was led by Meyers ($n = 2$) [Table 4].

Further statistical analysis

The Shapiro–Wilk test showed non-normally distributed data, $P = 0.00$. There was a positive, non-significant trend towards an increased total number of citations with age (correlation coefficient = 0.137, $P = 0.173$) [Figure 3]. On the other hand, there was a significant decrease in citation density as the article age increases (correlation coefficient = −0.723, $P = 0.000$) [Figure 4]. A non-significant trend has been noticed between the age of the journal and the number of articles published in the journal (correlation coefficient = 0.247, $P = 0.225$).

DISCUSSION

With this bibliometric analysis, the 100 most-cited articles in the field of MI GI surgery were identified. In

Table 1: The top 100 most-cited articles in the field of laparoscopic gastrointestinal surgery

Place	Article	Number of citations
1	Buchwald H. Bariatric surgery: A systematic review and meta-analysis. JAMA 2004	3331
2	Clinical Outcomes of Surgical Therapy Study Group. A comparison of laparoscopically assisted and open colectomy for colon cancer. N Engl J Med 2004	1613
3	Guillou PJ. Short-term endpoints of conventional versus laparoscopic-assisted surgery in patients with colorectal cancer (MRC CLASICC trial): Multicentre, randomised controlled trial. Lancet 2005	1579
4	Lacy AM. Laparoscopy-assisted colectomy versus open colectomy for treatment of non-metastatic colon cancer: A randomised trial. Lancet 2002	1437
5	Seymour NE. Virtual reality training improves operating room performance: Results of a randomized, double-blinded study. Ann Surg 2002	1234
6	Buchwald H. Weight and type 2 diabetes after bariatric surgery: Systematic review and meta-analysis. Am J Med 2009	1182
7	Schauer PR. Bariatric surgery versus intensive medical therapy in obese patients with diabetes. N Engl J Med 2012	951
8	Jacobs M. Minimally invasive colon resection (laparoscopic colectomy). Surg Laparosc Endosc 1991	907
9	Deziel DJ. Complications of laparoscopic cholecystectomy: A national survey of 4,292 hospitals and an analysis of 77,604 cases. Am J Surg 1993	851
10	Maggard MA. Meta-analysis: Surgical treatment of obesity. Ann Intern Med 2005	826
11	Schauer PR. Outcomes after laparoscopic Roux-en-Y gastric bypass for morbid obesity. Ann Surg 2000	806
12	Dixon JB. Adjustable gastric banding and conventional therapy for type 2 diabetes: A randomized controlled trial. JAMA 2008	806
13	Jayne DG. Randomized trial of laparoscopic-assisted resection of colorectal carcinoma: 3-year results of the UK MRC CLASICC Trial Group. J Clin Oncol 2007	805
14	Mingrone G. Bariatric surgery versus conventional medical therapy for type 2 diabetes. N Engl J Med 2012	796
15	Kitano S. Laparoscopy-assisted Billroth I gastrectomy. Surg Laparosc Endosc. 1994	784
16	Strasberg SM. An analysis of the problem of biliary injury during laparoscopic cholecystectomy. J Am Coll Surg 1995	754
17	Christou NV. Surgery decreases long-term mortality, morbidity, and health care use in morbidly obese patients. Ann Surg 2004	726
18	Schauer PR. Effect of laparoscopic Roux-en Y gastric bypass on type 2 diabetes mellitus. Ann Surg 2003	700
19	Semm K. Technical surgical steps of endoscopic appendectomy. Endoscopy. 1983	662
20	Cuschieri A. The European experience with laparoscopic cholecystectomy. Am J Surg 1991	637
21	Longitudinal Assessment of Bariatric Surgery (LABS) Consortium. Perioperative safety in the longitudinal assessment of bariatric surgery. N Engl J Med 2009	632
22	Nguyen NT. Laparoscopic versus open gastric bypass: A randomized study of outcomes, quality of life, and costs. Ann Surg 2001	621
23	Grantcharov TP. Randomized clinical trial of virtual reality simulation for laparoscopic skills training. Br J Surg 2004	615
24	Dubois F. Coelioscopic cholecystectomy. Preliminary report of 36 cases. Ann Surg. 1990.	605
25	Cancello R. Reduction of macrophage infiltration and chemoattractant gene expression changes in white adipose tissue of morbidly obese subjects after surgery-induced weight loss. Diabetes 2005	602
26	Veldkamp R. Laparoscopic surgery versus open surgery for colon cancer: Short-term outcomes of a randomised trial. Lancet Oncol. 2005	598
27	Leung KL. Laparoscopic resection of rectosigmoid carcinoma: Prospective randomised trial. Lancet 2004	596
28	Reddick EJ. Laparoscopic laser cholecystectomy. A comparison with mini-lap cholecystectomy. Surg Endosc 1989	577
29	Meyers WC. A prospective analysis of 1518 laparoscopic cholecystectomies. N Engl J Med 1991	571
30	Huscher CG. Laparoscopic versus open subtotal gastrectomy for distal gastric cancer: 3-year results of a randomized prospective trial. Ann Surg 2005.	557
31	Buchwald H. Metabolic/bariatric surgery worldwide 2011. Obes Surg 2013.	557
32	Luketich JD. Minimally invasive esophagectomy: Outcomes in 222 patients. Ann Surg 2003	556
33	Schauer PR. Bariatric surgery versus intensive medical therapy for diabetes-3-year outcomes. N Engl J Med 2014	536
34	Fleshman J. Laparoscopic colectomy for cancer is not inferior to open surgery based on 5-year data from the COST Study Group trial. Ann Surg 2007	525
35	Wittgrove AC. Laparoscopic gastric bypass, Roux-en-Y- 500 patients: Technique and results, with 3-60 month follow-up. Obes Surg 2000	523
36	le Roux CW. Gut hormone profiles following bariatric surgery favor an anorectic state, facilitate weight loss, and improve metabolic parameters. Ann Surg 2006	515
37	Sjöström L. Bariatric surgery and long-term cardiovascular events. JAMA 2012	508
38	Navarra G. One-wound laparoscopic cholecystectomy. Br J Surg 1997	505
39	Nguyen KT. World review of laparoscopic liver resection-2,804 patients. Ann Surg 2009	502
40	Buchwald H. Bariatric surgery worldwide 2003. Obes Surg 2004	481
41	Buell JF. The international position on laparoscopic liver surgery: The Louisville Statement, 2008. Ann Surg 2009	480
42	Dallemagne B. Laparoscopic Nissen fundoplication: Preliminary report. Surg Laparosc Endosc 1991	472
43	Neumayer L. Open mesh versus laparoscopic mesh repair of inguinal hernia. N Engl J Med 2004	468
44	Buchwald H. Metabolic/bariatric surgery Worldwide 2008. Obes Surg 2009	464
45	Kitano S. A multicenter study on oncologic outcome of laparoscopic gastrectomy for early cancer in Japan. Ann Surg 2007	462
46	Weeks JC. Short-term quality-of-life outcomes following laparoscopic-assisted colectomy vs open colectomy for colon cancer: A randomized trial. JAMA 2002	457
47	Fried GM. Proving the value of simulation in laparoscopic surgery. Ann Surg 2004. S	450

Contd...

Table 1: Contd...

Place	Article	Number of citations
48	Hinder RA. Laparoscopic Nissen fundoplication is an effective treatment for gastroesophageal reflux disease. Ann Surg 1994	440
49	Wittgrove AC. Laparoscopic Gastric Bypass, Roux-en-Y: Preliminary Report of Five Cases. Obes Surg 1994	439
50	Regan JP. Early experience with two-stage laparoscopic Roux-en-Y gastric bypass as an alternative in the super-super obese patient. Obes Surg 2003	429
51	Heniford BT. Laparoscopic repair of ventral hernias: 9 years' experience with 850 consecutive hernias. Ann Surg 2003	426
52	Scott DJ. Laparoscopic training on bench models: Better and more cost effective than operating room experience? J Am Coll Surg 2000	423
53	Karamanakos SN. Weight loss, appetite suppression, and changes in fasting and postprandial ghrelin and peptide-YY levels after Roux-en-Y gastric bypass and sleeve gastrectomy: A prospective, double blind study. Ann Surg 2008	423
54	Gallagher AG. Virtual reality simulation for the operating room: proficiency-based training as a paradigm shift in surgical skills training. Ann Surg 2005	417
55	Milsom JW.A prospective, randomized trial comparing laparoscopic versus conventional techniques in colorectal cancer surgery: A preliminary report. J Am Coll Surg 1998	413
56	Nagtegaal ID. What is the role for the circumferential margin in the modern treatment of rectal cancer?. J Clin Oncol 2008	413
57	Jayne DG. Five-year follow-up of the Medical Research Council CLASICC trial of laparoscopically assisted versus open surgery for colorectal cancer. Br J Surg 2010	413
58	Giulianotti PC. Robotics in general surgery: personal experience in a large community hospital. Arch Surg 2003	412
59	Mulier S. Local recurrence after hepatic radiofrequency coagulation: Multivariate meta-analysis and review of contributing factors. Ann Surg 2005	411
60	Kim HH. Morbidity and mortality of laparoscopic gastrectomy versus open gastrectomy for gastric cancer: an interim report-a phase III multicenter, prospective, randomized Trial (KLASS Trial). Ann Surg 2010	408
61	Wexner SD. Port site metastases after laparoscopic colorectal surgery for cure of malignancy. Br J Surg 1995	405
62	Podnos YD. Complications after laparoscopic gastric bypass: A review of 3464 cases. Arch Surg 2003	404
63	Dixon JB. Nonalcoholic fatty liver disease: Improvement in liver histological analysis with weight loss. Hepatology 2004	402
64	Marescaux J. Transatlantic robot-assisted telesurgery. Nature 2001	401
65	Tekkis PP. Evaluation of the learning curve in laparoscopic colorectal surgery: Comparison of right-sided and left-sided resections. Ann Surg 2005	397
66	Derossis AM. Development of a model for training and evaluation of laparoscopic skills. Am J Surg 1998	393
67	Davidoff AM. Mechanisms of major biliary injury during laparoscopic cholecystectomy. Ann Surg 1992.	390
68	Abraham NS. Meta-analysis of short-term outcomes after laparoscopic resection for colorectal cancer. Br J Surg 2004	387
69	Gagner M. Laparoscopic pylorus-preserving pancreatoduodenectomy. Surg Endosc 1994	386
70	Higa KD. Complications of the laparoscopic Roux-en-Y gastric bypass: 1,040 patients–what have we learned? Obes Surg 2000.	383
71	Rubino F. The early effect of the Roux-en-Y gastric bypass on hormones involved in body weight regulation and glucose metabolism. Ann Surg 2004.	378
72	Cherqui D. Laparoscopic Liver Resections: A Feasibility Study in 30 Patients. Ann Surg 2000	377
73	Peters JH. Safety and efficacy of laparoscopic cholecystectomy. A prospective analysis of 100 initial patients. Ann Surg 1991	376
74	Himpens J. A prospective randomized study between laparoscopic gastric banding and laparoscopic isolated sleeve gastrectomy: Results after 1 and 3 years. Obes Surg 2006	376
75	Laferrère B. Effect of weight loss by gastric bypass surgery versus hypocaloric diet on glucose and incretin levels in patients with type 2 diabetes. J Clin Endocrinol Metab 2008	376
76	Lanfranco AR. Robotic surgery: A current perspective. Ann Surg 2004	375
77	Biere SS. Minimally invasive versus open oesophagectomy for patients with oesophageal cancer: A multicentre, open-label, randomised controlled trial. Lancet 2012	368
78	Remzi FH. Single-port laparoscopy in colorectal surgery. Colorectal Dis 2008.	366
79	Futier E. A trial of intraoperative low-tidal-volume ventilation in abdominal surgery. N Engl J Med 2013	357
80	Buchwald H. Trends in mortality in bariatric surgery: A systematic review and meta-analysis. Surgery 2007	356
81	Picot J. The clinical effectiveness and cost-effectiveness of bariatric (weight loss) surgery for obesity: A systematic review and economic evaluation. Health Technol Assess 2009	351
82	Cottam D. Laparoscopic sleeve gastrectomy as an initial weight-loss procedure for high-risk patients with morbid obesity. Surg Endosc 2006	347
83	Kim YW. Improved quality of life outcomes after laparoscopy-assisted distal gastrectomy for early gastric cancer: Results of a prospective randomized clinical trial. Ann Surg 2008	346
84	Steinbrook R. Surgery for severe obesity. N Engl J Med 2004	344
85	Kang SB. Open versus laparoscopic surgery for mid or low rectal cancer after neoadjuvant chemoradiotherapy (COREAN trial): Short-term outcomes of an open-label randomised controlled trial. Lancet Oncol 2010	343
86	le Roux CW. Gut hormones as mediators of appetite and weight loss after Roux-en-Y gastric bypass. Ann Surg 2007	338
87	van der Pas MH. Laparoscopic versus open surgery for rectal cancer (COLOR II): Short-term outcomes of a randomised, phase 3 trial. Lancet Oncol 2013	337

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Table 1: Contd...

Place	Article	Number of citations
88	Liem MS. Comparison of conventional anterior surgery and laparoscopic surgery for inguinal-hernia repair. N Engl J Med 1997	333
89	Nduka CC. Abdominal wall metastases following laparoscopy. Br J Surg 1994	332
90	Chapman AE. Laparoscopic adjustable gastric banding in the treatment of obesity: A systematic literature review. Surgery 2004	329
91	Peters JH. Development and validation of a comprehensive program of education and assessment of the basic fundamentals of laparoscopic surgery. Surgery 2004	327
92	Cummings DE. Gastric bypass for obesity: Mechanisms of weight loss and diabetes resolution. J Clin Endocrinol Metab 2004	323
93	Hunter JG. A physiologic approach to laparoscopic fundoplication for gastroesophageal reflux disease. Ann Surg 1996	321
94	Bonjer HJ. Laparoscopically assisted vs open colectomy for colon cancer: A meta-analysis. Arch Surg 2007	321
95	Kojouri K. Splenectomy for adult patients with idiopathic thrombocytopenic purpura: A systematic review to assess long-term platelet count responses, prediction of response, and surgical complications. Blood 2004	320
96	Canes D. Transumbilical single-port surgery: evolution and current status. Eur Urol 2008	319
97	Joris JL. Hemodynamic changes during laparoscopic cholecystectomy. Anesth Analg 1993	318
98	Flum DR. Impact of gastric bypass operation on survival: A population-based analysis. J Am Coll Surg 2004	318
99	Koffron AJ. Evaluation of 300 minimally invasive liver resections at a single institution: Less is more. Ann Surg 2007	318
100	Langer FB. Sleeve gastrectomy and gastric banding: Effects on plasma ghrelin levels. Obes Surg 2005	317

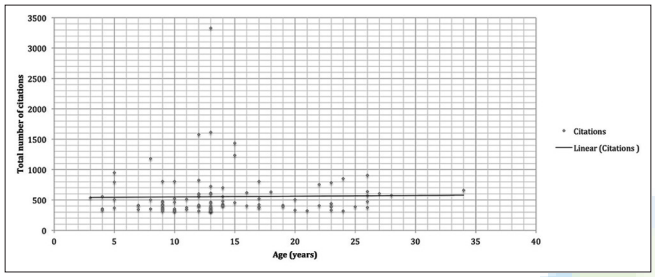

Figure 3: Graph illustrating the total number of citation change with age

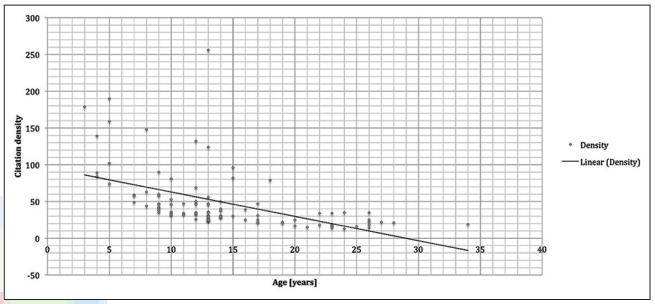

Figure 4: Change of citation density with age

1994, Wittgrove performed the first laparoscopic gastric bypass and ever since the number of bariatric procedures rocketed.[7] As a consequence, the field of bariatric surgery was the most-cited topic and contributed the most articles (n = 36) led by the article published by Buchwald *et al*. The meta-analysis on bariatric surgery was published in JAMA in 2004 and has been cited 3.331 times since then.[8] Three more articles in the top ten reported on bariatric surgery: an RCT on bariatric surgery versus medical treatment for type 2 diabetes by Schauer *et al*. and two meta-analyses on bariatric surgery by Buchwald *et al*. and Maggard *et al*.[9-11] The second most-cited topic was surgical oncology (n = 26), led by four top ten articles. In the study by Jacobs *et al*., the first series of laparoscopic-assisted colectomies in 20 patients was reported.[12] The other three top ten cited articles consisted of studies providing evidence that the oncologic outcome of laparoscopic colectomies is not compromised compared to the open approach.[13-15] Thereby, the studies contributed to establishing the laparoscopic access as gold standard in colon cancer. HPB surgery (n = 15) was identified as third hot topic, led by articles on laparoscopic cholecystectomies and resulting biliary injuries as more advanced laparoscopic HPB procedures such as MI liver and pancreatic resections just start to gain wider acceptance. As it takes time to accumulate citations for an article, novel trends are underrepresented in this citation analysis. Thus, the rapidly growing fields of MI liver (n = 4), pancreatic (n = 1), robotic assisted (n = 3) and single-access (n = 1) surgery have not been implemented long enough. They will certainly have a more prominent role on a future list of citation classics in MI GI surgery.

The quality of the included studies, measured by the level of evidence, varied greatly. Level I evidence was only provided by 20% of the publications, whereas low-level (IV and V) evidence provided 43% of all articles. Thus, to get highly cited, articles have to be extremely relevant to their field and set the standard of care such as well-designed RCTs or articles reporting innovative ideas. These can gain great attention even if they are case series. Citation analyses in the field of visceral surgery and bariatric surgery have reported similar results, showing that all levels of evidence are represented.[16,17]

As reported in the study by Callaham *et al*., the impact factor of a journal is the best predictor of the number of citations of an article.[18] This was confirmed in our study as 30% of the top-cited articles were in Annals of Surgery,

Table 2: Detailed overview of the journals in which the articles were published

Journal name	Number of articles	Quartile ranking	Country of publication
Annals of Surgery	30	Q1	USA
New England Journal of Medicine	10	Q1	USA
Obesity Surgery	9	Q1	Canada
British Journal of Surgery	6	Q1	UK
Lancet	4	Q1	UK
Journal of the American College of Surgeons	4	Q1	USA
Journal of the American Medical Association	4	Q1	USA
Archives of Surgery	3	Q1	USA
Surgical Endoscopy	3	Q1	USA
Lancet Oncology	3	Q1	USA
Surgery	3	Q1	USA
American Journal of Surgery	3	Q2	USA
Surgical laparoscopy and Endoscopy	3	Q2	USA
Journal of Clinical Endocrinology and Metabolism	2	Q1	USA
Journal of Clinical Oncology	2	Q1	USA
Endoscopy	1	Q1	Germany
European Urology	1	Q1	Netherlands
Colorectal Disease	1	Q1	UK
Health Technology Assessment	1	Q1	UK
Nature	1	Q1	UK
American Journal of Medicine	1	Q1	USA
Anesthesia and Analgesia	1	Q1	USA
Annals of Internal Medicine	1	Q1	USA
Blood	1	Q1	USA
Diabetes	1	Q1	USA
Hepatology	1	Q1	USA

Table 3: Levels of evidence and median number of citations of the top-cited articles

Level of evidence	Number of publications	Median number of citations (range)
I	20/100	395,5 (319-3331)
II	29/100	525 (321-1613)
III	8/100	395 (317-726)
IV	29/100	439 (318-907)
V	14/100	498 (327-851)

the journal with the highest impact in surgery, followed by the top journals in medicine namely New England Journal of Medicine and Lancet with 10% and 4% of the articles, respectively. However, compared to the citation analysis on the whole field of visceral surgery, studies were less often featured in top medicine journals (New England Journal of Medicine 38%, Lancet 13%) which may be due to the fact that laparoscopic surgery is a very specific topic with a lower relevance for physicians in general.

Over half of the articles (51%) originated from the USA. The USA remains the undisputed centre for global medical innovations not just in laparoscopic surgery but also in orthopaedics, general surgery and urology as well.[19-21] Factors are not only America's unmatched research activity but also its citation and reviewer behaviour as Campbell showed the tendency of authors from the UK and the USA to cite articles from their own countries.[22] Fitting into the renowned paradigm in which American journals have the propensity to accept papers from the USA, 42 of the 51 articles originating from the USA were published in American journals.

The citation analysis has several limitations. Even though the 19 keywords covered the whole spectrum of GI surgery, articles may have been missed. The analysis is furthermore limited by the fact that the older the article, the more time it had to get cited. In this study, 90% of the articles were published before 2010 and new innovations in laparoscopic surgery are under-represented in bibliometric studies.

It has to be questioned if citation numbers are a valid way to judge research. This intriguing issue was studied by Ioannidis *et al.* as they showed a strong relationship between high number of citations and the influence of the work.[23] However, the citation of an article is influenced by various factors: journal preferences when citing, the tendency to cite highly cited articles and the author's reputation, all of which work against the number of citations being an equitable reflector of the quality and impact of the work. Novel tools such as tweets, likes and publication downloads depict the social media impact and popularity of an article and interestingly may even predict highly cited articles within the first 3 days of article publication.[24] Therefore, traditional citation metrics will be complemented by novel social impact measures to value research.

CONCLUSION

The present study revealed citation classics in the field of laparoscopic GI surgery and identified hot topics, important discoveries and relevant contributors.

Table 4: List of authors with more than one published article in the top 100

	Number of articles	Topic
First author		
Buchwald H	6	Bariatric surgery
Schauer PR	4	Bariatric surgery
Dixon JB	2	Bariatric surgery (1) Hepatobiliary (1)
Flum DR	2	Bariatric surgery
Jayne DG	2	Oncology
Kitano S	2	Oncology
le Roux CW	2	Bariatric surgery
Peters JH	2	Hepatobiliary (1) General (1)
Wittgrove AC	2	Bariatric surgery
Senior author		
Meyers WC	3	Hepatobiliary (2) General (1)
Brown JM	2	Oncology
Oien DM	2	Bariatric surgery
Pomp A	2	Hepatobiliary (1) Bariatric surgery (1)
Satava RM	2	General
Sledge I	2	Bariatric surgery

Furthermore, it was shown that the number of citations does not translate into level of evidence and it should be kept in mind that bibliometric studies have several limitations.

Availability of data and material

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Conflicts of interest

There are no conflicts of interest.

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