Surg Endosc (2006) 20: 71–75
DOI: 10.1007/s00464-005-0091-z

SURGICAL ENDOSCOPY
and Other Interventional Techniques

Laparoscopic versus open incisional hernia repair

A single-institution analysis of hospital resource utilization for 884 consecutive cases

D. Earle, N. Seymour, E. Fellinger, A. Perez

Department of Surgery, Baystate Medical Center, Tufts University School of Medicine, 759 Chestnut Street, Springfield, MA 01199, USA

Received: 19 February 2005/Accepted: 19 July 2005/Online publication: 7 December 2005

Abstract
Background: To analyze hospital resource utilization for laparoscopic vs open incisional hernia repair including the postoperative period.
Methods: Prospectively collected administrative data for incisional hernia repairs were examined. A total of 884 incisional hernia repairs were examined for trends in type of approach over time. Starting October 2001, detailed records were available, and examined for operating room (OR) time, cost data, length of stay (LOS), and 30-day postoperative hospital encounters.
Results: Of the total, 469 incisional hernias were approached laparoscopically (53%) and 415 open (47%). Laparoscopic repair had shorter LOS (1 ± 0.2 days vs 2 ± 0.6 days), longer OR time (149 ± 4 min vs 89 ± 4 min), higher supply costs ($2,237 ± $71 vs $664 ± $113), slightly lower total hospital cost ($6,396 ± $477 vs $7,197 ± $1,819), and slightly more postoperative hospital encounters (15% vs 13%). Use of laparoscopy increased over time (37% in 2000 vs 68% in 2004).
Conclusions: Laparoscopic incisional hernia repair is becoming increasingly popular, and not at increased cost to the health care system.

Key words: Ventral hernia — Incisional hernia — Laparoscopy — Cost — Financial analysis

Approximately 13% (90,000) of all hernias performed yearly in the United States are incisional hernias [12]. LeBlanc first reported a laparoscopic incisional hernia repair in 1993 [7], and over time there has been an increase in both the volume and complexity of incisional hernia repairs approached laparoscopically. Although there have been several studies comparing clinical outcomes between laparoscopic and open incisional hernia repair, few have focused on a cost analysis between these two groups. [2, 6, 9] With the recent development of even more expensive biologic prosthetics for hernia repair, cost may play a more prominent role in resource allocation. Our aim is to analyze and compare the utilization of hospital resources associated with laparoscopic and open incisional hernia repair at a university-affiliated tertiary care center.

Correspondence to: D. Earle

Materials and methods

Prospectively collected data from an administrative database (Baystate Medical Center, Springfield, MA, USA) were examined. A total of 1,493 cases of ventral hernia repairs were performed between November 1999 and June 2004. To make the data more homogenous, we excluded 605 nonincisional hernias (556 umbilical, 36 epigastric, 13 parastomal, and 4 Spigelian). The remaining 884 adult incisional hernia repairs were used to trend any change in approach and case volume over time. Details of patient records were available starting October 2001, and we were able to examine 426 (158 open, 268 lap) patient records for operating room (OR) time (defined as the time between incision and closure), demographic information (patient gender and age, American Society of Anesthesiologists' [ASA] classification), OR supply and total hospital cost (not charges, amounts expressed in $US), length of stay (LOS, expressed in days), and patients with postoperative hospital encounters within 30 days of discharge from the original operation for hernia repair (includes emergency room (ER) visits with or without readmission, as well as direct readmissions to the hospital). We will use postoperative hospital encounters as a marker for additional hospital resource utilization. Our hospital and many primary care and specialty offices are part of an integrated regional health care system, and all postoperative encounters within our system were captured.

Data are expressed as mean ± standard error of the mean (SEM). Statistical comparisons or were by chi-square analysis, Fisher's exact test, and Student's *t*-test performed on commercially available software. All tests were two-tailed, and a p value of < 0.05 was considered to be statistically significant.

Results

For the entire time period, 469 (53%) incisional hernias were repaired by a laparoscopic approach, and 415 (47%) by open techniques. There was an increase in total volume over the time period studied, increasing from

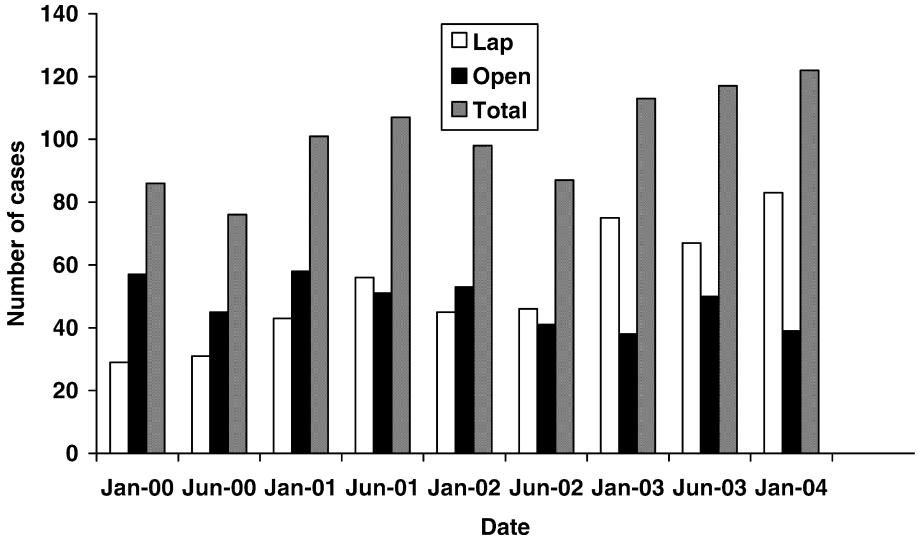

Fig. 1. Volume of laparoscopic and open incisional hernia repairs by semester. Note the steadily increasing volume of cases using the laparoscopic approach, and a slowly declining volume utilizing the open approach.

Table 1. Demographics of patients undergoing ventral hernia repair

	Lap (n = 268)	Open (n = 158)	p value
Age, mean (yr)	51 ± 0.6	53 ± 1.2	0.16
Female (%)	63%	51%	0.04
ASA class II	62%	57%	0.45
ASA class III	28%	28%	1.0

162 cases in 2000 to 230 cases in 2003. There was a statistically significant annual increase in the utilization of the laparoscopic approach, increasing from 34% in 2000 to 68% in 2004 (Fig. 1). Interestingly, 36 cases (4%) were reoperations for recurrent hernia of cases earlier in the series, most of which were done as open cases (27 open, 9 lap).

For the 426 patient records after October 2001, both groups were well matched for age and (ASA) classification. There were however, a significantly higher proportion of women in the laparoscopic group (male:female 1:1.7 lap, 1:0.95 open) (Table 1). Laparoscopic, compared to open repair, was associated with a shorter LOS (1 ± 0.2 days vs 2 ± 0.6 days), longer operative time (149 ± 4 min vs 89 ± 4 min), higher OR supply costs ($2,237 ± $71 vs $664 ± $113), and slightly lower total hospital cost ($6,396 ± $477 vs $7,197 ± $1,819) (Table 2). There were slightly more postoperative hospital encounters within 30 days of the operation (42/268, 16% vs 20/158, 13%) in the laparoscopic group. Postoperative hospital encounters were associated with a cost of $1,027 ± $1,206 ($2,101 ± $426 lap, $1,959 ± $427 open). The total hospital resource utilization including the initial hernia repair and postoperative encounter was $6,725 ± $457 for the laparoscopic group, and $7,445 ± $1,719 for the open group (Table 3).

A more detailed analysis of the postoperative encounters reveals that about half of the patients were ambulatory (not requiring admission to the hospital) ER visits with an associated cost of $457 ± $406 ($414 ± $31 lap, $523 ± $73 open), and half of the patients required readmission to the hospital (Table 4), with an associated cost of $3,531 ± $465 ($3,101 ± $190 lap, $3,176 ± $216 open) (Table 5). Those patients requiring readmission to the hospital had an average length of stay of 3 ± 0.3 days (3.0 ± 2 lap, 2.8 ± 1 open) (Table 5).

Of those requiring readmission, three patients in the laparoscopic group and one patient in the open group required reoperation for complications. For the readmission, these patients had an average LOS of 5 ± 0.8 days (6 [lap], 4 [open]; range 4–7 days), with an associated cost of $8,879 ± $1,458 ($9,869 lap, $5,909 open). When considering the groups as a whole, total hospital resource utilization in patients requiring reoperation for complications was $6,530 ± $475 in the laparoscopy group and $7,234 ± $1,813 in the open group (p = 0.61). When compared with the group of readmission that did not require reoperation, there was also no significant difference in cost. There was, however, a significant difference in LOS, favoring groups that did not require reoperation. LOS was 5.2 ± 0.75 and 2.7 ± 0.3 (p = 0.007) days in the readmission group that required reoperation vs those that did not (Table 6).

Discussion

The concept of minimally invasive surgery has changed many aspects in the surgical care of patients, regardless of the access techniques employed for a given patient. Most of the benefits are centered on improvements in the postoperative recovery period, including shorter lengths of hospital stay, fewer and less severe wound complications, and earlier return to normal activities. Another commonly stated benefit is decreased postoperative pain [11], but this is not necessarily the case for laparoscopic ventral hernia repair at our institution based on observational data. Despite the apparent lack of benefit with initial postoperative pain, however, there still seems to be a shorter overall recovery period, and there is clearly a shorter length of stay in the hospital (Table 2).

Table 2. Comparison of laparoscopic vs open incisional hernia repair

	Lap repair (n = 268)	Open repair (n = 158)	p value
OR time	149 ± 4 min	89 ± 4 min	<0.001
OR supply cost ($US)	2,237 ± 71	664 ± 113	<0.001
Total hospital cost of operation ($US)	6,396 ± 477	7,197 ± 1,819	0.59
Length of stay (d)	1 ± 0.2	2 ± 0.6	0.005

Table 3. Total postoperative hospital encounters

	Lap repair (n = 268)	Open repair (n = 158)	p value
No. of 30-day postoperative hospital encounters	42 (16%)	20 (13%)	0.47
Cost of postoperative hospital encounter ($US)	2,102 ± 426	1,959 ± 427	0.83
Total hospital utilization ($US) including initial operation and postoperative encounters	6,725 ± 457	7,445 ± 1,719	0.55

Table 4. Comparison of postoperative hospital encounters for laparoscopic vs open ventral hernia repair

	Lap repair (n = 42)	Open repair (n = 20)	p value
Ambulatory ER visits	20 (48%)	9 (45%)	0.92
Total admissions	22 (52%)	11 (55%)	0.92
Admissions through ER	16	8	0.88
Direct admissions	6	3	1.00
Length of stay (d)	3.0 ± 2	2.8 ± 1	0.85

Table 5. Comparison of costs associated with postoperative hospital encounters for laparoscopic vs open ventral hernia repair

	Lap repair (n = 42)	Open repair (n = 20)	p value
Cost for ER visit (US$)	414 ± 31	523 ± 73	0.56
Cost for readmission (US$)	3,101 ± 190	3,176 ± 216	0.94

These benefits, however, have come at the cost of amplified technical demands for surgeons and operating rooms, necessitating more expensive (often disposable) instruments and equipment, and increased time spent in the operating room. Like many laparoscopic procedures, it appears that the overall benefits outweigh the disadvantages. This is likely the reason for the clear increase in the utilization of the laparoscopic approach at our institution in the past 5 years (Fig. 1), a trend that has been echoed by others [5].

For incisional hernia repair, the generally accepted "best practice" is the retromuscular placement of a prosthetic [8]. If the location of the prosthetic is intraperitoneal, it must be compatible with direct visceral contact. Products that are considered to meet this requirement are more expensive than plain polypropylene prosthetics that are commonly utilized for open incisional hernia repairs, where the prosthetic is placed in an extraperitoneal location. There is, however, some debate about the safety of intraperitoneal polypropylene placement [6, 13]. For the laparoscopic approach at our institution, although there is some variability of actual technique, we nearly exclusively utilize intraperitoneal expanded polytetraflouroethylene (ePTFE; Gore-Tex Dual Mesh; WL Gore; Flagstaff, AZ, USA). A combination of permanent sutures and spiral tacks is used to secure the mesh in place. The open approaches have considerably more variability, and include the use of primary repair with absorbable and nonabsorbable sutures, as well as various polypropylene products, ePTFE, and biologic prosthetics. Additionally, placement of the prosthetic is not uniformly in a retromuscular position, rather a mix of techniques also including inlay repair (edge of mesh to edge of defect), onlay repair (anterior to the abdominal wall, with or without closure of the fascia), and "sandwich" repair (retromuscular combined with onlay) with a variety of fixation techniques. In summary, although there is surgeon variability for both approaches, the laparoscopic group represents a more homogenous population regarding the technical aspects of the hernia repair, but it is doubtful if this had any effect on the hospital resource utilization seen between the two approaches, with the exception of the OR supply costs, and possibly OR time. The wide variation of open techniques makes it difficult to draw definitive conclusions.

Another limitation is the lack of clinical information regarding complexity of the hernias in each group. We have used ASA classification to stratify overall patient risk, but the complexity of the technical portion of the operation was not available in the data set. This allows a potential undetected selection bias for type of procedure performed, though the cases were unselected, consecutive, and included all patients (both inpatient and outpatient, emergency and elective) with incisional hernia repair. Because of the large numbers and inclusion of all patients, we believe the addition of clinical data regarding complexity of hernia repair is unlikely to change the cost findings. Our observation is that the type of repair is usually dependent on the surgeon, rather than the complexity of the hernia.

Table 6. Comparison of readmissions that had reoperation with those that did not have reoperation

	Readmission with reoperation $n = 3$ (lap), 1 (open)	Readmission without reoperation $n = 19$ (lap), 9 (open)	p value
LOS (d)	5 (lap), 4 (open)	2.6 (lap), 1.5 (open)	NS[a]
Cost for readmission (US$)	$6,530 (lap), $7,234 (open)	$6,612 (lap), $7,383 (open)	NS[a]

[a] Not significant for all comparisons except LOS in lap group reoperation vs no reoperation ($p = 0.01$) and LOS for both groups reoperation vs no reoperation ($p = 0.007$)

It is ironic that the increased cost of providing less invasive surgical care of incisional hernia is often associated with less reimbursement for both hospitals and surgeons, making it difficult from a financial viewpoint to justify the approach, despite a clinical advantage [1, 4, 14]. An additional financial hurdle for ventral hernia is the lack of differentiation in coding for the procedure. A small incisional hernia from a previous laparoscopic port site in a thin patient is coded the same as a large, multiply recurrent incisional hernia with skin ulceration in an obese patient. The difference in OR time may be as great as 6 h, and the lack of coding differentiation creates negative financial value to the surgeon and institution, and may adversely affect access to care for complex and high-risk hernia patients.

DeMaria and colleagues [2] showed that laparoscopic ventral hernia repair is characterized by less painful recovery and shorter hospital stay, with 90% of patients treated successfully as outpatients as compared with 7% in the open group. The total facility costs for the laparoscopic repair were significantly lower than for the open repair, something we did not see in our study, as both groups had equal total hospital costs. DeMaria et al. concluded that laparoscopic repair had advantages over open repair in terms of decreased hospitalization, postoperative pain, and disability. Interestingly, 14% of their laparoscopic patients were readmitted to the hospital, compared to 28% of their open cases. In our series, there was no difference in the rate of return to the hospital between the two groups (16% lap, 13% open), and only about half of those required readmission to the hospital (8% lap, 7% open). Those readmitted stayed for an average of 5.2 ± 0.75 days if reoperation was required, and 2.7 ± 0.3 days if there was no reoperation. Because of the small number of patients requiring reoperation, there was no statistically significant impact on total cost when looking at the two groups as a whole. Although not statistically different, the laparoscopic group was associated with a lower mean total hospital cost by $720 when considering the initial procedure and postoperative hospital encounters. From a national viewpoint, this could potentially represent $64,800,000 annual savings considering the volume of incisional hernia repairs in the United States.

Another potential limitation of the current study is the fact that we were not able to distinguish the difference in outpatient visits for routine postoperative care and for complications. Additionally, we were unable to capture any visits or readmissions that occurred outside our health care system. The administrative nature of the data naturally make clinical outcomes difficult if not impossible to evaluate, but are satisfactory for the financial analyses. Regarding the postoperative ambulatory ER visits, we postulate that they may be due to a national trend toward earlier discharge, routine use of the ER as an urgent care center, and lack of availability of urgent visit capacity in doctors' offices.

We conclude that despite the stated controversy over the laparoscopic approach to incisional hernia [3, 10], there is a clear trend toward the laparoscopic approach. The reasons for this are likely the same as for the proliferation of any new technique, and are focused on both patient and surgeon satisfaction with the technique and the results. A more detailed analysis of clinical outcomes, as well as patient and surgeon satisfaction, is necessary to delineate the reason for the evolution toward laparoscopic treatment of incisional hernia. Additionally, the laparoscopic approach does not cost more than the open approach when considering total hospital resource utilization for both the operative episode and postoperative hospital encounters within 30 days. It is necessary to create an economic environment that allows the approach with the best value for a given patient to be utilized, and that all patients regardless of complexity have access to a given approach.

References

1. Carbajo MA, Martin del Olmo JC, Blanco JI, de la Cuesta C, Toledano M, Martin F, Vaquero C, Inglada L (1999) Laparoscopic treatment vs open surgery in the solution of major incisional and abdominal wall hernias with mesh. Surg Endosc 13: 250–252
2. DeMaria EJ, Moss JM, Sugerman HJ (2000) Laparoscopic intraperitoneal polytetrafluoroethylene (PTFE) prosthetic patch repair of ventral hernia. Prospective comparison to open prefascial polypropylene mesh repair. Surg Endosc 14: 326–329
3. Egea DA, Martinez JA, Cuenca GM, Miquel JD, Lorenzo JG, Albasini JL, Jordana MC (2004) Mortality following laparoscopic ventral hernia repair: lessons from 90 consecutive cases and bibliographical analysis. Hernia 8: 208–212
4. Goodney PP, Birkmeyer CM, Birkmeyer JD (2002) Short-term outcomes of laparoscopic and open ventral hernia repair: a meta-analysis. Arch Surg 137: 1161–1165
5. Heniford BT, Park A, Ramshaw BJ, Voeller G (2003) Laparoscopic repair of ventral hernias: nine years' experience with 850 consecutive hernias. Ann Surg 238: 391–399
6. Holzman MD, Purut CM, Reintgen K, Eubanks S, Pappas TN (1997) Laparoscopic ventral and incisional hernioplasty. Surg Endosc 11: 32–35
7. LeBlanc KA, Booth WV (1993) Laparoscopic repair of incisional abdominal hernias using expanded polytetrafluoroethylene: preliminary findings. Surg Laparosc Endosc 3: 39–41
8. Luijendijk RW, Hop WC, van den Tol MP, de Lange DC, Braaksma MM, IJzermans JN, Boelhouwer RU, de Vries BC, Salu MK, Wereldsma JC, Bruijninckx CM, Jeekel J (2000) A com-

parison of suture repair with mesh repair for incisional hernia. N Engl J Med 343: 392–398
9. McGreevy JM, Goodney PP, Birkmeyer CM, Finlayson SR, Laycock WS, Birkmeyer JD (2003) A prospective study comparing the complication rates between laparoscopic and open ventral hernia repairs. Surg Endosc 17: 1778–1780
10. Moreno-Egea A, Torralba JA, Girela E, Corral M, Bento M, Cartagena J, Vicente JP, Aguayo JL, Canteras M (2004) Immediate, early, and late morbidity with laparoscopic ventral hernia repair and tolerance to composite mesh. Surg Laparosc Endosc Percutan Tech 14: 130–135
11. Raftopoulos I, Vanuno D, Khorsand J, Kouraklis G, Lasky P (2003) Comparison of open and laparoscopic prosthetic repair of large ventral hernias. J Soc Laparosc Endosc Surg 7: 227–332
12. Toy FK, Bailey RW, Carey S, Chappuis CW, Gagner M, Josephs LG, Mangiante EC, Park AE, Pomp A, Smoot RT Jr, Uddo JF Jr, Voeller GR (1998) Prospective, multicenter study of laparoscopic ventral hernioplasty. Preliminary results. Surg Endosc 12: 955–959
13. Vrijland WW, Jeekel J, Steyerberg EW, Den Hoed PT, Bonjer HJ (2000) Intraperitoneal polypropylene mesh repair of incisional hernia is not associated with enterocutaneous fistula. Br J Surg 87: 348–352
14. Wright BE, Niskanen BD, Peterson DJ, Ney AL, Odland MD, VanCamp J, Zera RT, Rodriguez JL (2002) Laparoscopic ventral hernia repair: are there comparative advantages over traditional methods of repair? Am Surg 68: 291–295