

Single-incision laparoscopy surgery: a systematic reviewSasan Saeed far¹, Sepide Miraj²

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Abstract

Background: Laparoscopic surgery is a modern surgical technique in which operations are performed far from their location through small incisions elsewhere in the body.

Objective: This systematic review is aimed to overview single-incision laparoscopy surgery.

Methods: This systematic review was carried out by searching studies in PubMed, Medline, Web of Science, and IranMedex databases. The initial search strategy identified about 87 references. In this study, 54 studies were accepted for further screening and met all our inclusion criteria [in English, full text, therapeutic effects of single-incision laparoscopy surgery and dated mainly from the year 1990 to 2016]. The search terms were “single-incision,” “surgery,” and “laparoscopy.”

Results: Single-incision laparoscopy surgery is widely used for surgical operations in cholecystectomy, sleeve gastrectomy, cholecystoduodenostomy, hepatobiliary disease, colon cancer, obesity, appendectomy, liver surgery, rectosigmoid cancer, vaginal hysterectomy, vaginoplasty, colorectal lung metastases, pyloroplasty, endoscopic surgery, hernia repair, nephrectomy, rectal cancer, colectomy and uterus-preserving repair, bile duct exploration, ileo-ileal resection, lymphadenectomy, incarcerated inguinal hernia, anastomosis, congenital anomaly, colectomy for cancer.

Conclusion: Based on the findings, single-incision laparoscopy surgery is a scarless surgery with minimal access. Although it possesses lots of benefits, including less incisional pain and scars, cosmesis, and the ability to convert to standard multiport laparoscopic surgery, it has some disadvantages, for example, less freedom of movement, fewer number of ports that can be used, and the proximity of the instruments to each other during the operation.

Keywords: Single-incision, Surgery, Laparoscopy

1. Introduction

Traditionally, it is believed that there are different types of treatment: through herbal remedies (1-10), through drug or pharmacotherapy (11, 12), and finally through surgery (7, 13). Laparoscopic surgery is a newly developed operation technique carried out via small incisions far from their place in the body (14, 15). Single-port laparoscopy is a modern technique in laparoscopic surgery (16). During this technique, surgery was done via a single entry point, generally the patient's navel; further, in this kind of surgery, only a single small scar is left behind (17, 18). Specialized equipment for SPL surgery falls into two broad categories: access ports and hand instruments. Single-incision laparoscopic surgery (SILS) is well-known for its cosmetic benefit (19). In fact, although this technique is confirmed to have lots of benefits in human studies, including less incisional pain and scars, cosmesis, and the ability to convert to standard multiport laparoscopic surgery, there is a great deal of confusion about its application in animal studies or human improvement. To achieve this purpose, many studies have been carried out to

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concentrate on determining if there are any benefits in pain or recovery. This systematic review is aimed to overview single-incision laparoscopy surgery.

2. Material and Methods

2.1. Design

This systematic review was carried out by searching studies in PubMed, Medline, Web of Science, and IranMedex databases. The initial search strategy identified about 128 references. In this study, 46 studies were accepted for further screening and met all our inclusion criteria [in English, full text, therapeutic effects of “single-incision,” “surgery,” “laparoscopy”].

2.2. Eligibility criteria

Inclusion criteria included the following keywords used to search for relevant articles published from March 1990 to March 2016, their full text should be available, to be in English. Articles included consisted of clinical trials, in vitro, in vivo, review, or meta-analysis studies. Exclusion criteria as just abstracts were not available in the time line of this study. Those articles not matching our inclusion criteria (in other languages than English, between the timeline of study) were excluded from the study.

2.3. Quality assessment

To assess the quality of articles, all sections of article were checked with the STROBE checklist (29). In the screening and selection of article, presence of inclusion and exclusion criteria was also checked. Based on the search results, 70 articles were identified. Nevertheless, 16 studies were excluded from the review, leaving 54 articles for further analysis.

3. Results and discussion

3.1. Cholecystectomy

Single incision laparoscopic cholecystectomy was evaluated from a safety point of view through a novel instrument. The result suggested that this technique lasts longer and loses more blood without patient usefulness, but, when using a novel instrument, it possesses less blood loss and is safer than SILC with a conservative instrument. Thus this technique can be a potential substitute in cholecystectomy (20). In a study, the clinical findings of single-incision laparoscopic cholecystectomy by a modern technique was shown. The findings showed the safety and feasibility of this modern technique. Besides, this technique was shown to be a standard method for those surgeons who have never performed SILC before, not needing the application of articulating instruments (21). The impact of postoperative day (POD) 2 CT scan after LSG was prospectively assessed. The results found that a POD 2 abdominal CT scan is an efficient diagnostic tool for detecting active bleeding/hematoma but shows less impressive results with a gastric staple line leak detection. A combination of clinical surveillance and early imaging allowed prompt management of complicated cases, avoiding further morbidity (22). The safety and feasibility of mini-laparoscopic cholecystectomy (mini-Lch) has not been documented with a large patient sample. Six patients developed an incisional hernia at the umbilical port site, and 16 patients had umbilical wound infection. Patient acceptance was excellent; postoperative analgesic requirement was less effective. With Mini Lch, a better cosmetic result was achieved, recovery was early. Minilaparoscopic cholecystectomy is an economic feasibility and more acceptable considering the cosmetic outcome and patient acceptance. Results indicate that this procedure could be performed successfully and safely by experienced surgeons (23). In the case of single incision laparoscopic cholecystectomy, the risk factors of traditional laparoscopic cholecystectomy were investigated. Although SILC is a simple and possible technique for most patients with benign GB disease, CLC is a riskier technique with more blood loss in patients with acute cholecystitis or GB (24). The preliminary results of a randomized prospective study regarding the feasibility and safety of LESS cholecystectomy versus classic laparoscopic technique was presented. LESS technique compared with a traditional technique show some advantages such as demonstrated: acceptable operative times, lower post-operative discomfort, and sometimes reduction-added complications. Fewer incisions and less scarring, which mean less pain, were demonstrated, and fewer parietal complications are related to this surgical procedure. In conclusion in the elderly, LESS cholecystectomy technique is to be considered a suitable alternative to traditional three-port cholecystectomy (25). The cosmetic outcome of SILC versus conventional laparoscopic cholecystectomy (CLC) in the rural Indian population was evaluated. The result showed that the patient perception and acceptance of SILC was better than that of CLC in terms of cosmetic outcome (26). An initial experience in SSRC was presented, and its clinical outcomes with those of SILC was compared. Patients in both groups had similar demographic features and indications for surgery. Both SSRC and SILC are safe and feasible procedures for performing single incision cholecystectomy. SSRC, however, has the advantage of significantly

decreased postoperative pain (27). An initial experience in SSRC was presented, and its clinical outcomes with those of SILC were compared. Patients in both groups had similar demographic features and indications for surgery. Both SSRC and SILC are safe and feasible procedures for performing single incision cholecystectomy. SSRC, however, has the advantage of significantly decreased postoperative pain (27).

3.2. Cholecystoduodenostomy

In vivo experimental study, the feasibility of laparoscopic cholecystoduodenostomy in canine cadavers using barbed self-locking sutures was evaluated. The surgical procedure was performed with four 5 mm entry ports and a 5 mm 30° telescope. Leaks were managed by placement of a single reinforcing conventional intracorporeal suture, which was adequate for obtaining a watertight anastomosis. This technique cannot be recommended in clinical practice until further studies are performed and the technique is further refined (28).

3.3. Hepatobiliary disease

Regarding to hepatobiliary diseases, the futurity of minimally invasive surgery is reviewed. In spite of having the risk of incidence of complications accompanied with anastomosis, laparoscopic surgery is done cautiously for choledochal cyst, while robotic surgery is done for hepatobiliary disease for more minimally invasive surgery. Meanwhile, improvement of robotic technology is a necessity to have more convenient and cheaper instrument and surgical technique should be enhanced to minimize duration of operation (29). Laparoscopic trans fistulous bile duct surgery for MS type II was investigated. The patients with MS type II undergoing laparoscopic bile duct exploration aged significantly lesser and suffered more from jaundice. Besides, they had longer surgical duration, received a lower postoperative pethidine dose, and were hospitalized longer. Result showed that this technique is proved to be safe and practical for MS type II. However, long-term follow-up is of high importance (30).

3.4. Cancer

The learning curve (LC) for single-incision laparoscopic right hemicolectomy (SILRC), incorporating complete mesocolic excision to resect right-sided colon cancer, was investigated through multidimensional techniques. By comparison, significant differences in patients of phase 2 included larger tumor size, higher harvested lymph node counts, longer proximal resection margins, and more advanced disease. In terms of operative time and surgical success, SILRC is feasible for surgeons experienced in LS but may prove more challenging for novices, given the fundamental technical difficulties of this procedure (31). In an animal study, the efficacy and cosmetic result of suprapubic single incision laparoscopic surgery (SSILS) in the treatment of rectosigmoid cancer was evaluated. In experienced laparoscopic treatment centers, SSILS for rectosigmoid cancer is feasible and safe with quite good oncological efficacy and certain advantages, such as fast recovery, less pain, and better cosmetic result (32). There has been great enthusiasm for the technique of transanal total mesorectal excision. Coupled with this procedure, we performed single-incision laparoscopic surgery for left colon mobilization. This is a description of our initial experience with the combined approach. Results showed transanal total mesorectal excision with single-incision laparoscopy to be a feasible option for rectal cancer. Patients reported minimal postoperative pain. Further studies on the long-term outcome are warranted (33). The first experience with this minimally invasive approach was demonstrated. The study showed that simultaneous trans-diaphragmatic resection of peripheral lung lesions is feasible for patients undergoing laparoscopic liver resection. The low invasiveness of the described technique could facilitate an aggressive operative approach to SLLM (34). The results of single-incision right colectomy (SIRC) with the results of the standard laparoscopic right colectomy (SLRC) in patients with colon cancer was compared. Result showed that SIRC is feasible and sure for patients with colon cancer. As compared with SLRC, SIRC may offer some advantages, including lower operative morbidity, shorter hospital stay, and better cosmeses, without compromising the oncological quality of the resected specimen (35). A laparoscopic single-incision technique that is minimally invasive without requiring intracorporeal anastomosis was presented. Operative time, post-operative complications, hospital length of stay, and narcotic utilization were similar between the single-port and traditional laparoscopic groups. Laparoscopic removal of small bowel tumours with a small, periumbilical trocar incision is both effective and feasible without advanced technical skill (36).

3.5. Obesity

The impact of body habitus on outcomes after SILA in the pediatric population was assessed. Results indicate that obesity does not have a significant impact on outcomes after SILA. SILA can be performed in overweight and obese children with no significant difference in operative time, length of stay, or incidence of surgical site infection. SILA should continue to be offered to overweight and obese children (37).

3.6. Appendectomy

In a study on appendicitis, a single-incision laparoscopic appendectomy was compared with a three-port appendectomy. The study suggests that the first technique is a quicker and cheaper method in comparison with 3PA for acute appendicitis. SIA did not increase infection for acute appendicitis and is a good substitute for 3PA in an appendicitis operation (38). The efficacy of single-incision transumbilical laparoscopy-assisted appendectomy was investigated by surgical residents. Result showed that, in the resident-operated group, blood loss rate and duration of surgery were significantly higher and longer. No other significant difference was observed. Transumbilical laparoscopy-assisted appendectomy is confirmed to be safe. It is part of a surgical training (39). Feasibility of single-incision laparoscopic appendectomy was performed with technical modifications. No significant peri-operative complication was reported. Average follow-up lasted 32 weeks. The feasibility and safety of this technique via conventional instruments were proved (40). A homemade glove port technique for single-incision laparoscopic appendectomy (SILA) was reported. No conversion to open surgery in both the groups was observed. One case of umbilical surgical site infection was reported. SILA showed that a homemade glove port was a safe and cost-effective technique (41). In an *in vivo* study, efficacy of the undergoing laparoscopic appendectomy was investigated. Dermal incision for laparoscopic appendectomy performing post-TAP block showed that it does not significantly affect postoperative analgesia results (42).

3.7. Liver

The history, indications, contraindications, ideal patients for new beginners, technical difficulty, advantages, disadvantages, oncological concern, and the future of SPL-LR were reviewed. Hepatopancreatobiliary surgeons are reluctant to operate on a malignant lesion through a narrow incision with limited exposure. There are concerns over adverse oncological outcomes for single-port laparoscopic liver resections (SPL-LR) for hepatocellular carcinoma or metastatic colorectal cancer. In addition, getting familiar with using the operating instruments through a narrow incision with limited exposure is challenging (43).

3.8. Vaginal complications

The safety of gasless single-port laparoscopy in vaginal hysterectomy was evaluated. The median surgical duration in the single-port LAVH group was significantly longer than that in the multiport LAVH group. The result showed that a gasless single-port LAVH and multiport LAVH are potential methods to produce the same main surgical results, with minimum scarring (44). Transumbilical single-incision laparoscopic was evaluated in women with MRKH syndrome. No intraoperative morbidity was observed and surgery was successfully performed. The result showed that the above technique is a feasible scarless method with a cosmetic advantage for women with MRKH syndrome to establish new functional vagina (45). The first attempt of a novel, minimally invasive technique for managing a case of benign colouterine fistula with single-incision laparoscopic (SIL) sigmoid colectomy and uterus preservation was reported. Findings showed that single-incision laparoscopy in complicated diverticular disease and fistula formation cases is a challenging but technically feasible option in experienced hands (46). The safety and efficacy of one-stage single-incision laparoscopic-assisted anorectoplasty (SILAARP) as an alternative to the conventional approach was evaluated. Postoperative pelvic magnetic resonance imaging verified the centrally placed rectum within the muscle complex. Most patients started having bowel movements on postoperative day 1. Two constipated patients periodically required an enema for one to three months. One-stage SILAARP is safe and effective. It provides complete rectification of ARM with recto-urethral fistula immediately after birth with good cosmesis (47). An experience in this single case of laparoscopic Finney pyloroplasty (LFP) performed in the emergency setting for a woman with a perforated duodenal ulcer and severe loss of tissue in D1-D2 was reported. Due to the presence of severely inflamed perforation edges and the risk of duodenal narrowing with subsequent GOO, the Finney technique was favored over direct ulcer repair. The patient achieved a full postoperative recovery free of complications, with a dynamic oral contrast study demonstrating good gastric evacuation. Although LFP requires a specific surgical skill-set, it can be effective and feasible in cases of duodenal perforation with significant loss of mural substance (48). The safety and feasibility of pure retroperitoneal natural orifice transluminal endoscopic surgery (NOTES) transvaginal nephrectomy using conventional laparoscopic techniques in a porcine model was investigated. Findings confirmed the safety and feasibility of the retroperitoneal pure retroperitoneal NOTES transvaginal nephrectomy using standard laparoscopic instruments, which suggested the possibility of clinical application in human beings in the future (47).

3.9. Hernia repair

The safety and feasibility of SILS-TAPP compared with the TAPP technique was evaluated. Port site hernia (PSH) rate was significantly high in the SILS-TAPP group, and all PSHs were recorded in patients with severe

comorbidities. SILS TAPP for inguinal hernia repair seems to be a feasible, safe method and is comparable with the TAPP technique. However, randomized trials are required to evaluate long-term clinical outcomes (49). The feasibility of single-incision laparoscopic percutaneous extraperitoneal closure (LPEC) for incarcerated inguinal hernia (IIH) repair was examined. Procedures were done via single incision without open mutation. The result showed that, for IIH repair, single-incision LPEC with a multi-channel port is a safe technique (50).

3.10. Nephrectomy

Standard laparoscopic nephrectomy and LESS-DN was compared based on their uses and harms for a live kidney. As far as the sample size of included studies were small, the superiority of LESS-DN than laparoscopic donor nephrectomy is uncertain. More human studies are required to define more thoroughly the role of LESS-DN as a minimally invasive surgery technique for kidney donor surgery (51).

3.11. Ileo-ileal resection

Intermittent abdominal pain of the right lower quadrant in a case of a 45-year-old man for 1 month was reported. The duration of surgery was about 1 hour and hospitalized for 2 days post-surgery. The patient recovered well with least possible scar results (52).

3.12. Lymphadenectomy

The techniques of single-port laparoscopic transperitoneal infrarenal paraaortic lymphadenectomy was shown. The result demonstrated that, although single-port surgery is still a difficult operation, single-portlaparoscopic transperitoneal infrarenal para-aortic node dissection is considered remarkable. As an oncologic procedure, the aforementioned technique is acceptable for ovary and endometrial cancer surgeries (53).

3.13. Anastomosis

The safety of a minimally invasive single-stage technique was investigated in a patient with Hinchey IV. The expert surgeon can perform laparoscopy safely and entirely via mini-Pfannenstiel incision (54, 55).

4. Conclusions

Based on the findings, a single-incision laparoscopy surgery is scarless surgery with minimal access. Although it possesses lots of benefits, including less incisional pain and scars, cosmesis and the ability to convert to standard multiport laparoscopic surgery, it has some disadvantages, for example, less freedom of movement, fewer number of ports that can be used, and the proximity of the instruments to each other during the operation.

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Conflict of Interest:

There is no conflict of interest to be declared.

Authors' contributions:

Both authors contributed to this project and article equally. Both authors read and approved the final manuscript.

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