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Incidence, natural course, and characteristics of postlaparoscopic shoulder pain

Dong Hee Lee[1] · Taejong Song[1] · Kye Hyun Kim[1] · Kyo Won Lee[1]

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Abstract
Background To determine the incidence, natural course, and specific characteristics of postlaparoscopic shoulder pain (PLSP).
Methods The prospective study included 105 patients undergoing laparoscopy for benign gynecologic diseases. The intensity of pain, and the identification of the pain site, was assessed 24- and 48-h after surgery, using a visual analogue scale. The description and intensity of PLSP, its aggravating and relieving factors, and the response to analgesics were assessed over a 1-week period using a self-reported questionnaire.
Results Of 105 patients, 84 (80%) experienced PLSP. PLSP along with wound pain peaked one day after surgery, gradually subsided, and were not reported by the seventh day after surgery. Of the 84 patients experiencing PLSP, 77 (91.7%) had aggravating and relieving factors, which included position change (48.8%) and rest (42.9%), respectively. Analgesics provided significantly less pain relief for PLSP (32.7 ± 32.2%), when compared to relief of wound pain (68.0 ± 16.2%) ($P < 0.001$).
Conclusion PLSP, identified in 80% of our patients, resolved in most patients within the first week after laparoscopy. Since PLSP is less responsive to analgesics, when compared to wound pain, surgeons should pay attention to the prevention of PLSP among patients undergoing laparoscopy.

✉ Taejong Song
taejong.song@gmail.com

[1] Department of Obstetrics and Gynecology, Kangbuk Samsung Hospital, Sungkyunkwan University School of Medicine, 29 Saemunan-ro, Jongno-gu, Seoul 03181, Republic of Korea

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Laparoscopy has been widely used over the past three decades for the general, urologic, and gynecologic surgeries. The advantages of laparoscopic surgery include smaller incision size, less postoperative pain, lower requirement for analgesia, shorter hospitalizations, earlier return to normal activity, and lower morbidity [1–4]. However, laparoscopic surgery is associated with shoulder pain after surgery, which rarely occurs in open surgeries [5–9]. The precise mechanism of postlaparoscopic shoulder pain (PLSP) is unclear, but it is believed that residual carbon dioxide after laparoscopic surgery induces an irritation of the phrenic nerve, leading to referred shoulder pain [5, 10, 11]. In some cases, PLSP may cause more discomfort to the patient than incisional pain [5–9].

However, there are no studies identifying the clinical characteristics of PLSP. With the increased demand by patients for less painful and less debilitating surgery, a study focusing on the nature of PLSP is required. Therefore, we conducted a prospective cohort study to determine the incidence and natural course of PLSP, and to identify specific characteristics of PLSP in patients who underwent gynecologic laparoscopy.

Materials and methods

Participants

The Institutional Review Board approved this study protocol. The study was prospectively conducted between March 2016 and August 2016 at the Kangbuk Samsung

Hospital, Seoul, Republic of Korea. Written informed consent was obtained from all study participants. All study participants were women. Inclusion criteria were as follows: laparoscopy for benign gynecologic diseases; age, 19–75 years; not pregnant at the time of surgery; and an American Society of Anesthesiology physical status of I–II. Patients with chronic shoulder pain, chronic epigastric pain or chronic pain syndrome, a history of shoulder surgery, or regular use of opioids or analgesics were excluded from the study. In addition, patients who required conversion from laparoscopic surgery to open surgery, or concomitant upper abdominal surgery, due to adhesions and iatrogenic injury at the upper abdominal cavity, were excluded. Finally, patients who could not understand or fill in the pain diary, because of major medical comorbidities or psychiatric illnesses, were excluded.

Study treatment

All patients underwent the same standard presurgical preparation prior to surgery. An experienced surgeon (T. Song), with a history of performing more than 1000 laparoscopic procedures, performed all procedures. Placement of the laparoscopic port (or trocar) was determined according to the individual patient's specific condition and needs. Laparoendoscopic single-site surgery (LESS) and multiport laparoscopy were used as previously described [12, 13]. Any local anesthesia was not infiltrated into the wound before inserting the trocars in all cases. In cases of LESS, a single multi-channel port was inserted through the umbilicus, and the abdomen was insufflated to 14 mmHg with carbon dioxide gas. In cases of multiport laparoscopy, a single 12 mm trocar was inserted in the umbilicus and two or three ancillary 5 mm trocars were inserted in the lower abdomen. A 5 mm laparoscope was introduced through the umbilical port, and the intended surgical procedure was performed. After the laparoscopic procedure was completed by washing the pelvic cavity and absorbing any clots that had formed, the laparoscopic port was removed. A Jackson–Pratt drain was placed in the Douglas pouch only when diffuse oozing or a pelvic abscess was detected at the operative site. In all cases, the evacuation process of CO2 was performed at the end of laparoscopic surgery. It consists of the following: end of laparoscopic procedure; cessation of CO_2 insufflation in the deep Trendelenburg position; opening all the trocars (ports); upper abdominal pressure by the surgeons' hands to evacuate the residual CO_2; with the patient in horizontal position, lower abdominal pressure by the surgeons' hand; removal of the trocars; and closure of the wounds.

The postoperative pain management protocol of our hospital routinely provides intravenous patient-controlled analgesia (IV-PCA) for all patients for laparoscopy. Non-steroidal anti-inflammatory drugs (ibuprofen, 200 mg) are administered regularly, three times daily. Rescue analgesia (ketorolac tromethamine, 30 mg intravenously) is provided when requested by the patient. In our study, patients were discharged from the hospital when they were ambulatory, and no longer required narcotic analgesics. All patients were scheduled for follow-up examinations at 1 week and then 3 months after surgery.

Outcome measure

The primary outcome measure was the intensity of postoperative pain. We used a visual analogue scale (VAS), at 24- and 48-h after surgery, to measure the intensity and location of pain. The location of the pain (pain site) was identified as low abdomen or wound, versus shoulder tip. The scale was presented as a 10-cm line, with verbal descriptors indicating, "no pain" to "pain as bad as it could be." The secondary outcome measures were the incidence, natural course, and characteristics of PLSP. Patients were given a self-report questionnaire, including the pain diary, to be completed during the hospital stay and daily for the one-week period after surgery. Patients were also asked to respond to eight additional questions, including the description and intensity of PLSP, aggravating and relieving factors, prodromal symptoms, associating symptoms, and response to pain medications. Independent assessors collected questionnaires at the 1-week post-surgery visit, before patients saw their clinician. Sociodemographic characteristics including age, employment status, residence, marital status, number of children, and other clinical characteristics were prospectively obtained from the electronic medical records.

To assess the content validity for each item of our questionnaire, we organized a panel of seven experts. Each item was assessed on a 4-point scale: 1 = not relevant; 2 = somewhat relevant; 3 = quite relevant; and 4 = highly relevant. As a result, we confirmed that the internal validity of our questionnaire was high, ranging from 0.83 to 1.0.

Statistical analysis

The sample size was determined with reference to the primary outcome measure, the intensity of PLSP. Data from 30 consecutive patients, who underwent laparoscopy for benign gynecologic disease (authors' unpublished data), showed that the intensity of PLSP was 3.39 ± 2.54 points, on the VAS, at 24-h post-surgery. Therefore, after setting a confidence interval at 95%, margin of error at 0.5 point of VAS score, and dropout rate at 5%, the sample size required was 105 patients.

SPSS software (version 18.0; SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Qualitative data are

presented as frequency (percentage). In cases of quantitative variables, after assessing the normality of the data, mean ± standard deviation (SD) and median (interquartile range, IQR) were used to describe normal and non-normal distribution, respectively. The Student *t* test was used to compare continuous variables. A *P* value of <0.05 was considered statistically significant.

Results

Baseline characteristics of the study population are shown in Table 1. Mean age and body mass index of the 105 patients were 41.0 ± 12.1 years and 23.4 ± 4.2 kg/m^2, respectively. Surgical procedures included laparoscopic adnexal surgery ($n = 56$; 53.3%), hysterectomy ($n = 28$; 26.7%), and myomectomy ($n = 21$; 20.0%). Most patients underwent less (90.5%), and did not receive Jackson–Pratt drainage (99.0%). Mean operative time, operative blood loss (calculated by the anesthesiology unit as the difference between the total amount of suction and irrigation plus the difference between the total gauze weight before and after surgery), and length of the hospital stay (defined as the time from the operation day to the day of discharge) were 72.6 ± 35.3 min, 54.5 ± 54.0 mL, and 2.1 ± 0.5 days, respectively.

Table 1 Baseline characteristics of 105 patients undergoing laparoscopic surgery

	n (%) or mean (SD)
Age (years)	41.0 ± 12.1
Body mass index (kg/m^2)	23.4 ± 4.2
Parity	
Nulliparous	45 (42.9)
Parous	60 (57.1)
Marital status	
Single, separated, widowed, or divorced	38 (36.2)
Married or cohabiting	67 (63.8)
History of abdominal or pelvic surgery	37 (35.2)
Residence	
Urban	91 (86.7)
Rural	14 (13.3)
Employment status	
Employed	55 (52.4)
Unemployed	50 (47.6)
Surgical procedure	
Adnexal surgery[a]	56 (53.3)
Myomectomy	21 (20.0)
Hysterectomy	28 (26.7)
Laparoscopic approach	
Laparoendoscopic single-site surgery	95 (90.5)
Conventional multiport laparoscopy	10 (9.5)
Insertion of pelvic (Jackson–Pratt) drain	
Yes	1 (1.0)
No	104 (99.0)
Operative time (min)	72.6 ± 35.3
Operative blood loss (mL)	54.5 ± 54.0
Postoperative hospital stay (days)	2.1 ± 0.5

SD standard deviation

[a] Adnexal surgeries include ovarian cystectomy, oophorectomy, salpingectomy, and salpingo-oophorectomy

Based on the self-reported questionnaire, 84 of 105 patients experienced PLSP during a 1-week postsurgical period, which is an incidence of 80.0% (Fig. 1). When the 84 patients experiencing PLSP were in hospital, we measured the relative intensity of pain with specifying the pain site (low abdomen [or wound] versus shoulder tip) at 24- and 48-h post-surgery. Twenty-four hours after surgery, 33 patients (39.3%) reported that the wound pain was more severe than the shoulder pain (i.e., the wound was more painful than the shoulder); 41 (48.8%) reported that the wound pain was less severe than the shoulder pain; and 10 (11.9%) reported that the wound pain was equal to the shoulder pain. Forty-eight hours after surgery, 46 patients (54.8%) reported that wound pain was more severe than shoulder pain; 28 (33.3%) reported that wound pain was less severe than shoulder pain; and 10 (11.9%) reported that wound pain was equal to shoulder pain.

The intensity, onset, duration, and description of PLSP are shown in Table 2. The intensity of PLSP was 4.4 ± 2.2 points at 24 h after surgery and 3.3 ± 2.1 points at 48 h after surgery, while the intensity of wound pain was 4.0 ± 2.0 points at 24 h after surgery and 3.8 ± 1.5 points at 48 h after surgery. In 80.9% of patients, PLSP lasted 1–30 min, while in 14.9% of patients, it lasted more than 30 min. Patients characterized their pain as "squeezing" ($n = 37$; 44.0%); "dull" ($n = 25$; 29.8%); "stabbing" ($n = 14$;16.7%); and "lacerating" ($n = 8$; 9.5%).

Figure 2 demonstrates the natural history of PLSP. PLSP along with wound pain peaked one day after surgery, gradually subsided, and were not reported by the seventh day after surgery. Of 84 patients experiencing PLSP, 77 (91.7%) described aggravating or relieving factors; 63 patients (75.0%) had no prodromal symptoms; and 67 patients (79.8%) had various associated symptoms (Table 3). The most common aggravating factors, in order of frequency, were position change (48.8%), walking (27.4%), coughing (26.2%), and deep breathing (21.4%). The only relieving factor reported was rest (42.9%).

When patients were asked how much their pain was relieved by analgesics, 68.0 ± 16.2% stated that analgesics decreased wound pain, while 32.7 ± 32.2% stated that analgesics decreased shoulder pain ($P < 0.001$), suggesting

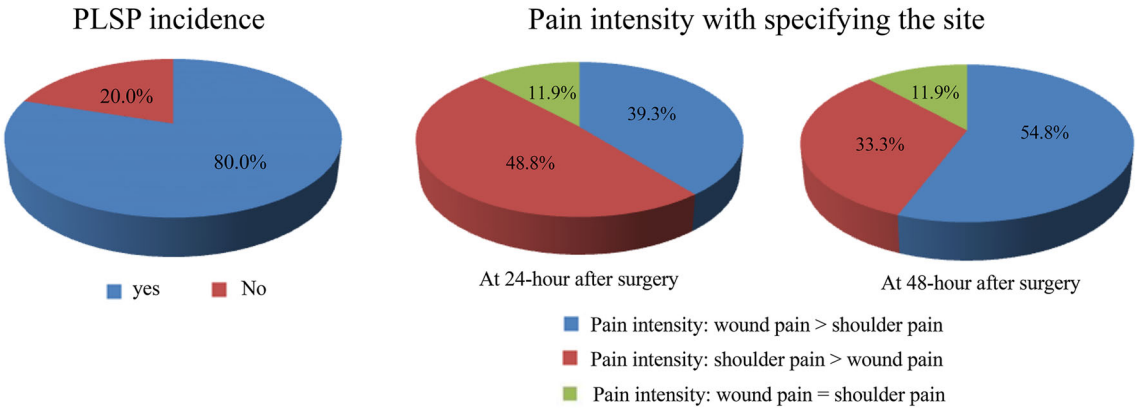

Fig. 1 The incidence of postlaparoscopic shoulder pain (PLSP)

Table 2 Characteristics of postlaparoscopic shoulder pain in 84 patients

	n (%) or mean (SD)
Pain intensity, VAS	
Shoulder pain at 24-h post-surgery	4.4 ± 2.2
Shoulder pain at 48-h post-surgery	3.3 ± 2.1
Wound pain at 24-h post-surgery	4.0 ± 2.0
Wound pain at 48-h post-surgery	3.8 ± 1.5
Pain onset	
Sudden	54 (64.3%)
Gradual	30 (35.7%)
Pain duration	
Within 1 min	4 (4.8%)
Within 1–30 min	68 (80.9%)
Exceeding 30 min	12 (14.3%)
Pain description	
Stabbing	14 (16.7%)
Lacerating	8 (9.5%)
Dull	25 (29.8%)
Squeezing	37 (44.0%)

VAS visual analogue scale

that PLSP is less responsive to analgesics, when compared to wound pain.

Discussion

In this study, we found that the incidence of PLSP in patients who underwent gynecologic laparoscopy was 80%. We also found that PLSP and wound pain reached a peak at one day after surgery, gradually subsided, and were not reported by 7 days after surgery. The pain associated with PLSP showed specific characteristics, in terms of duration, aggravating and relieving factors, and response to analgesics. To the best of our knowledge, this is the first study to determine the incidence, natural course, and specific characteristics of PLSP, in patients who underwent laparoscopy.

While our study showed an 80% incidence of PLSP, previous studies report that the incidence varies from 35 to 80% [7, 8, 11]. The higher incidence of PLSP in our study could be explained by a higher proportion of LESS (90.5%), and very low use of pelvic Jackson–Pratt drains (1.0%). Our hypothesis is consistent with that of Hoyer-Sorensen et al., [14] who reported that shoulder pain was significantly more frequent among women who underwent LESS than those who underwent multiport laparoscopy [3.1 (IQR 4) versus 1.4 (IQR 2); $P = 0.03$], despite similar levels of wound pain in both groups. The authors speculated that the increase in PLSP in patients who underwent LESS was due to the reduced ability to expel the operative gases through a single port. Furthermore, in our study, the incidence of PLSP may also be related to the infrequent insertion of a Jackson–Pratt drain.

The findings of the present study showed that PLSP was not evident 7 days after surgery. Although there are no studies on the natural history of PLSP, our findings are in agreement with the natural history of pneumoperitoneum after laparoscopy. Millitz et al. studied the duration of postlaparoscopic pneumoperitoneum, detected on upright chest radiographs, in 55 patients who underwent laparoscopic cholecystectomy [15]. Upright posteroanterior chest radiographs were obtained 6 h after surgery (day 1); additional radiographs were obtained, as required, until the pneumoperitoneum resolved (days 2, 4, 7, and 14). These authors reported that the pneumoperitoneum resolved, in most patients, within the first week after surgery.

Surprisingly, we found that PLSP, when compared to wound pain, was less responsive to analgesics (32.7 ± 32.2 vs. 68.0 ± 16.2%). Therefore, we believe that the prevention of PLSP is more important than the treatment of PLSP. Several strategies have been proposed to prevent PLSP, including the intraperitoneal instillation of saline

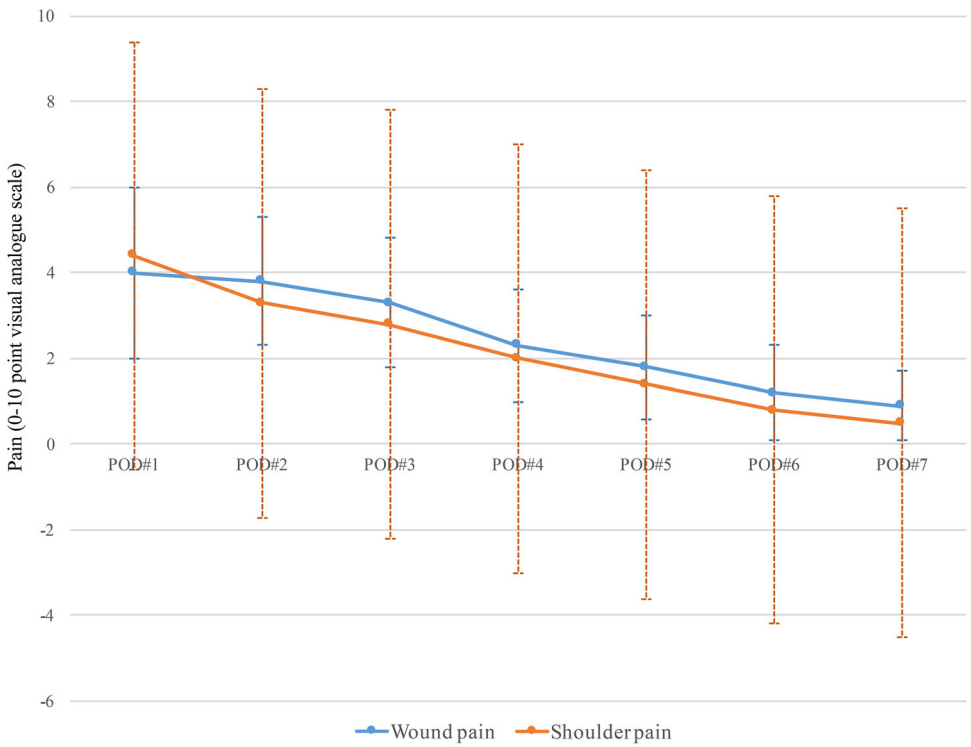

Fig. 2 Natural history of pain after laparoscopy

Table 3 Clinical factors related with postlaparoscopic shoulder pain in 84 patients

	n (%)
Aggravating factor	
No	7 (8.3)
Yes	77 (91.7)
Cough	22 (26.2)
Deep breathing	18 (21.4)
Walking	23 (27.4)
Position change	41 (48.8)
Relieving factor	
No	48 (53.1)
Yes	36 (42.9)
Rest	36 (42.9)
Prodromal symptom	
No	63 (75.0)
Yes	21 (25.0)
Nausea	13 (62.0)
Muscle spasm	4 (19.0)
Miscellaneous	4 (19.0)
Associated symptoms	
No	17 (20.2)
Yes	67 (79.8)
Chest pain	21 (31.3)
Dyspnea or breathlessness	29 (43.3)
Sweating	12 (17.9)
Dizziness	13 (19.4)
Nausea or vomiting	20 (29.9)
Epigastric pain	20 (29.9)
Back pain	13 (19.4)

and local anesthesia [16], use of a pulmonary recruitment maneuver [17], low pressure pneumoperitoneum during laparoscopic surgery [18], and subdiaphragmatic catheter insertion [19]. We are also conducting a randomized controlled trial (ClinicalTrials.gov Identifier: NCT02811081) to prevent PLSP in patients undergoing gynecologic laparoscopy.

In an attempt to abrogate PLSP, Cunniffe et al. prospectively evaluated the efficacy of intraoperative irrigation of the diaphragm with bupivacaine [20]. One hundred and five consecutive patients undergoing laparoscopic surgery were prospectively randomized to treatment or control groups. Treatment group ($n = 55$) received irrigation with 10 mL 0.5% bupivacaine in 500 mL saline and control group ($n = 50$) received an equal volume of normal saline. The overall incidence of PLSP in patients undergoing laparoscopic procedures was approximately 24%. Twenty-one patients (42%) in the control group and 4 patients (7%) in the treatment group complained of shoulder pain during the recording period ($P = 0.003$). Mean PLSP scores were significantly lower in the treatment group than in the control group from 4 to 24 h after surgery ($P < 0.01$). Therefore, Cunniffe et al. concluded that intraperitoneal irrigation with bupivacaine to both hemi-diaphragms at the end of surgery significantly reduces both frequency and intensity of PLSP following laparoscopic procedures thus reducing patient morbidity [20].

This study has some limitations. First, the study participants were only Korean women with gynecologic diseases.

Because the perception of pain and the response to pain has racial, cultural, and sexual differences [21, 22], our results might not apply in other populations. Second, most of the procedures were performed by LESS, and the frequency of insertion of pelvic drains was very low. Therefore, some caution is warranted in interpreting our results. However, the strength of this study is that the data were collected prospectively, and this is the first study providing detailed clinical characteristics of PLSP.

In conclusion, PLSP, which occurred in 80% of our patients, resolved in most patients within the first week after surgery. Since PLSP was less responsive to analgesics, when compared to wound pain, surgeons should focus on the prevention of PLSP in patients undergoing laparoscopy. Additional studies, conducted in various surgical settings (e.g., general surgery, Western countries, or male patients), are warranted to validate the results of our study.

Compliance with ethical standards

Disclosures Drs. Taejong Song, Dong Hee Lee, Kye Hyun Kim, and Kyo Won Lee have no conflicts of interest or financial ties to disclose.

References

1. Grace PA, Quereshi A, Coleman J, Keane R, McEntee G, Broe P, Osborne H, Bouchier-Hayes D (1991) Reduced postoperative hospitalization after laparoscopic cholecystectomy. Br J Surg 78:160–162
2. Valla JS, Limonne B, Valla V, Montupet P, Daoud N, Grinda A, Chavrier Y (1991) Laparoscopic appendectomy in children: report of 465 cases. Surg Laparosc Endosc 1:166–172
3. Nieboer TE, Johnson N, Lethaby A, Tavender E, Curr E, Garry R, van Voorst S, Mol BW, Kluivers KB (2009) Surgical approach to hysterectomy for benign gynaecological disease. Cochrane Database Syst Rev. doi:10.1002/14651858.CD003677
4. Gerbershagen HJ, Aduckathil S, van Wijck AJ, Peelen LM, Kalkman CJ, Meissner W (2013) Pain intensity on the first day after surgery: a prospective cohort study comparing 179 surgical procedures. Anesthesiology 118:934–944
5. Mouton WG, Bessell JR, Otten KT, Maddern GJ (1999) Pain after laparoscopy. Surg Endosc 13:445–448
6. Fredman B, Jedeikin R, Olsfanger D, Flor P, Gruzman A (1994) Residual pneumoperitoneum: a cause of postoperative pain after laparoscopic cholecystectomy. Anesth Analg 79:152–154
7. Cason CL, Seidel SL, Bushmiaer M (1996) Recovery from laparoscopic cholecystectomy procedures. Aorn J 63:1099–1103 **1106-1098, 1111-1092 passim**
8. Madsen MR, Jensen KE (1992) Postoperative pain and nausea after laparoscopic cholecystectomy. Surg Laparosc Endosc 2:303–305
9. Dobbs FF, Kumar V, Alexander JI, Hull MG (1987) Pain after laparoscopy related to posture and ring versus clip sterilization. Br J Obstet Gynaecol 94:262–266
10. Jackson SA, Laurence AS, Hill JC (1996) Does post-laparoscopy pain relate to residual carbon dioxide? Anaesthesia 51:485–487
11. Kandil TS, El Hefnawy E (2010) Shoulder pain following laparoscopic cholecystectomy: factors affecting the incidence and severity. J Laparoendosc Adv Surg Tech A 20:677–682
12. Song T, Kim MK, Kim ML, Yoon BS, Seong SJ (2014) Would fewer port numbers in laparoscopy produce better cosmesis? Prospective study. J Minim Invasive Gynecol 21:68–73
13. Song T, Kim TJ, Lee SH, Kim TH, Kim WY (2015) Laparoendoscopic single-site myomectomy compared with conventional laparoscopic myomectomy: a multicenter, randomized, controlled trial. Fertil Steril 104:1325–1331
14. Hoyer-Sorensen C, Vistad I, Ballard K (2012) Is single-port laparoscopy for benign adnexal disease less painful than conventional laparoscopy? A single-center randomized controlled trial. Fertil Steril 98:973–979
15. Millitz K, Moote DJ, Sparrow RK, Girotti MJ, Holliday RL, McLarty TD (1994) Pneumoperitoneum after laparoscopic cholecystectomy: frequency and duration as seen on upright chest radiographs. AJR Am J Roentgenol 163:837–839
16. Donatsky AM, Bjerrum F, Gogenur I (2013) Intraperitoneal instillation of saline and local anesthesia for prevention of shoulder pain after laparoscopic cholecystectomy: a systematic review. Surg Endosc 27:2283–2292
17. Sharami SH, Sharami MB, Abdollahzadeh M, Keyvan A (2010) Randomised clinical trial of the influence of pulmonary recruitment manoeuvre on reducing shoulder pain after laparoscopy. J Obstet Gynaecol 30:505–510
18. Esmat ME, Elsebae MM, Nasr MM, Elsebaie SB (2006) Combined low pressure pneumoperitoneum and intraperitoneal infusion of normal saline for reducing shoulder tip pain following laparoscopic cholecystectomy. World J Surg 30:1969–1973
19. Pergialiotis V, Vlachos DE, Kontzoglou K, Perrea D, Vlachos GD (2015) Pulmonary recruitment maneuver to reduce pain after laparoscopy: a meta-analysis of randomized controlled trials. Surg Endosc 29:2101–2108
20. Cunniffe MG, McAnena OJ, Dar MA, Calleary J, Flynn N (1998) A prospective randomized trial of intraoperative bupivacaine irrigation for management of shoulder-tip pain following laparoscopy. Am J Surg 176:258–261
21. Sheffield D, Biles PL, Orom H, Maixner W, Sheps DS (2000) Race and sex differences in cutaneous pain perception. Psychosom Med 62:517–523
22. Nayak S, Shiflett SC, Eshun S, Levine FM (2000) Culture and gender effects in pain beliefs and the prediction of pain tolerance. Cross Cult Res 34:135–151