Randomised Controlled Trial

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Comparison of gallbladder extraction via the subxiphoid port and the supraumbilical port during laparoscopic cholecystectomy: a prospective randomized clinical trial

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Background: Postoperative pain after laparoscopic cholecystectomy (LC) is the most frequent postoperative complaint. To date, gallbladder extraction via the subxiphoid port (SXP) versus the supraumbilical port (SUP) is still controversial. Thus, the authors performed this randomized controlled trial to compare postoperative pain between the SXP and SUP for LC.

Method: From June 2021 to June 2023, patients who met the inclusion criteria were randomly assigned to two groups. The perioperative data of both groups were recorded and compared.

Results: A total of 253 patients were enrolled in the analysis. There were 126 in the SXP group and 127 in the SUP group. There was no significant difference between the two groups in terms of the duration of gallbladder extraction, whether the incision was extended, the least rate of pain, the average rate of pain, the right-now rate of pain, postoperative pain on the 5th, 7th, and 14th days, postoperative complications and Vancouver Scar scale. However, the SUP group had a lower the worst rate of pain (4.24 ± 2.45 vs. 4.91 ± 2.45, $P = 0.031$) and 3 days of pain (3.35 ± 1.57 vs. 3.75 ± 1.52, $P = 0.045$) than did the SXP group. The influence of pain on general activity (4.51 ± 2.90 vs. 3.76 ± 2.92, $P = 0.041$), mood (3.62 ± 2.66 vs. 2.92 ± 2.36, $P = 0.028$), walking ability (4.40 ± 3.01 vs. 3.66 ± 2.76, $P = 0.044$), and enjoyment of life (3.19 ± 2.68 vs. 2.32 ± 2.34, $P = 0.007$) in the SXP was more severe than that in the SUP.

Conclusion: The extraction of the gallbladder via the SUP is superior to that via the SXP because the early postoperative 24 h pain and pain on the third day are mild and do not increase the duration of gallbladder extraction or the risk of infection or hernia.

Keywords: gallbladder extraction, laparoscopic cholecystectomy, postoperative pain, randomized clinical trial

Introduction

Laparoscopic cholecystectomy (LC) has become the standard of care for patients who require gallbladder removal because it reduces postoperative pain, as well as the risk of surgical site infection (SSI) and incisional hernia[1,2]. However, with the increasing number of laparoscopic operations, reports of complications have also increased. According to recent studies, the incidence of incisional hernia has risen from 0.18 to 2.8%[3,4], and the incidence of SSI at port sites has reached 5%[5]. These complications occur more frequently in patients with comorbidities such as advanced age, diabetes mellitus, and obesity[3,4,6]. Besides, pain is still the most frequent complaint after surgery, even after multimodal analgesia protocols, and is also the main reason that patients are readmitted to the hospital[7].

Retrieval of the gallbladder is the last process of LC. The gallbladder can be extracted from either the subxiphoid port or umbilical port, and no data are available to guide the choice of technique; the gallbladder may be extracted as the surgeon prefers[2]. Some studies have shown that gallbladder retrieval from the umbilical port is associated with less pain at the port-site than at the epigastric port[6,8]. However, other studies have shown that retrieval from the subxiphoid port could reduce the

HIGHLIGHTS

- It is the biggest sample and the most comprehensive postoperative evaluation about the subxiphoid port and the supraumbilical port.
- Patients who underwent gallbladder extraction via the supraumbilical port had less postoperative pain.

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Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

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risk of hernia and SSI[5,9]. However, previous studies had important shortcomings, such as having only a few different surgical procedures, insufficient analgesia, small sample sizes, different stone sizes, different BMIs, and a lack of scar formation assessments, which could have led to bias in these studies.

Therefore, we conducted this prospective randomized controlled trial (RCT) to provide high-quality clinical evidence about which approach is more suitable for gallbladder extraction. We set limits on stone size, unified analgesic strategies and surgical procedures. Then, postoperative pain, complications, and incisional scar formation were assessed to compare gallbladder extraction via the subxiphoid port and the supraumbilical port during LC. This is the largest sample size and the most comprehensive postoperative evaluation study to date. The aim of this study was to help surgeons select the best choice for patients during LC.

Materials and methods

Study design

The trial is designed as a prospective, randomized, double-blinded study and was conducted in the Division of Biliary Surgery, Department of General Surgery, from June 2021 to June 2023. This study was approved by the Clinical Trial Ethics Committee (Authorization number: No. 2021-243), and all patients provided informed consent. This study was performed according to the CONSORT guidelines[10]. The study protocol and ethics approval are available on this website.

Patients

Patients who met the inclusion criteria were randomized into two groups. One group was the subxiphoid port (gallbladder extraction via the subxiphoid port, SXP) group, and the other group was the supraumbilical port (gallbladder extraction via the supraumbilical port, SUP) group. The inclusion criteria were as follows: (1) patients who were diagnosed with gallstones or cholecystic polyps with or without chronic cholecystitis and who underwent LC; (2) had single or multiple gallstones with a maximum diameter $\leq$1.2 cm and a maximum diameter of gallbladder polyp $\leq$1.2 cm and a gallbladder wall thickness $\leq$0.6 cm; (3) were aged 18–65 years; (4) had 18 kg/m^2 $\leq$ BMI $\leq$ 30 kg/m^2; (5) had no history of diabetes; and (6) had no history of mental disorders and agreed to provide informed consent. The exclusion criteria were as follows: (1) had acute cholecystitis, common bile duct stones, or gallbladder carcinoma; (2) had a history of epigastric surgery; (3) had a cicatricial diathesis; (4) were addicted to alcohol (according to the Alcohol Use Disorders Identification Test [AUDIT]) or pain killers; and (5) had long-term oral hormone use.

Randomization and blinding

The randomization numbers were automatically created by Microsoft Excel (Office16). These random numbers were placed in sealed envelopes, which were kept by the staff of our group. Patients meeting the criteria were randomly allocated at a 1:1 ratio to either the SXP or SUP group according to the randomization sequence. Patients were fully informed of the process and objective of this trial, but they were blinded to the study intervention (SXP or SUP). Once patients were identified for inclusion by preliminary screening, sealed envelopes were brought into the operating room, and surgeons were informed of the patients' allocation when the gallbladder was removed from the port. Patients who meet the inclusion criteria before surgery will be excluded from the study if any of the following conditions occur: (1) gallbladder extraction time exceeds 10 min; (2) Gallbladder rupture results in contamination of the abdominal cavity; (3) Postoperative pathology confirms gallbladder carcinoma; and (4) Conversion to an open operation. Perioperative outcomes were assessed by one investigator who was also blinded to the study intervention until the end of the trial.

Anesthetic process

(1) Patients were intravenously injected with phencyclidine 0.01 mg/kg, midazolam 0.03 mg/kg, and parecoxib 40 mg, or flurbiprofen axetil 50 mg.
(2) Anesthesia was induced in patients via 3–5 μg/ml or 2–3 mg/kg propofol target-controlled infusion (TCI), 0.3–0.4 μg/kg sufentanil via i.v., or 0.15 mg/kg cisatracurium.
(3) After tracheal intubation, maintenance of anesthesia depended on propofol TCI or inhalation of sevoflurane/desflurane. Patients received 0.15 mg/kg cisatracurium and 0.3–0.4 ug/kg sufentanil or 0.05–0.2 μg/kg/min remifentanil.
(4) When the operation was finished, 5 mg tropisetron or 8 mg ondansetron was used to stop vomiting.

Surgical procedures

1. Patients were placed in a supine position with their legs together in a slight reverse trendelenburg position and a left rotation position.
2. The standard method is the three-port technique. A skin incision of ~1.0 cm was made in the supraumbilical region, through which a Veress needle was inserted using a closed technique for insufflation of carbon dioxide (CO_2) to establish pneumoperitoneum, followed by trocar insertion. The pressure was set at 13 mmHg. After the establishment of CO_2 pneumoperitoneum, a brief exploration was performed, and an additional 12 mm port was placed in the subxiphoid location, with a 5 mm port in the right midclavicular line. The right anterior axillary line was used if necessary.
3. Calot's triangle was retracted and dissected. This exposed one or two cystic arteries and the cystic duct. Clips were then placed on the cystic artery and the cystic duct on the side of the gallbladder. Then, the cystic duct was doubly clipped on the common duct side. Both the cystic and common ducts were transected by a knife. The gallbladder was dissected off the liver bed using electrocautery.
4. The gallbladder was then placed in a gallbladder retrieval bag and removed from the wound port.
5. Local infiltration of ropivacaine into the port. Then, 2-0 absorbable sutures were used to suture the peritoneum and abdominal wall. Polypropylene sutures were used to sew skin via intradermal sutures.

Perioperative multimodal analgesia regimen

(1) Oral administration of 400 mg celecoxib for preemptive analgesia was performed one day before surgery.
(2) 40 mg parecoxibna was given intravenously 6 h after the operation, and 40 mg celecoxib capsules were taken when the patient's pain score exceeded 6.

Primary outcomes

The primary endpoints included the time of gallbladder extraction, location of pain, postoperative brief pain inventory (BPI) score at 24 h, incision complications, and the visual analogue scale (VAS) on the 3rd day. Gallbladder extraction begins when the gallbladder is placed in the bag until it is removed from the port. The BPI has nine items covering three dimensions: the degree of pain, the nature of pain, and the impact of pain on daily life. The BPI also records the location of pain and the effect of drugs on pain.

Secondary outcomes

The secondary outcomes included the VAS score on the 5th, 7th, and 14th days, if painkiller use was ended, and the Vancouver scar scale (VSS) score.

Statistical analysis

All the data were processed and analyzed by SPSS (Version 24) software and GraphPad Prism software (version 10). Normally distributed data are presented as the mean ± SD; otherwise, the median and interquartile range M (IQR), and the count data, such as the effective rate, are reported as the frequency and rate (%). Independent sample *t*-tests were used for continuous variables with normality and homogeneity of variance, and Wilcoxon rank sum tests or Fisher exact tests were used for categorical variables with heterogeneity of variance. All statistical tests were two-sided, and the significance level was set at $\alpha = 0.05$.

Results

Patient characteristics

From June 2021 to June 2023, a total of 253 patients who met the criteria were assigned to the SXP group ($n = 126$) or the SUP group ($n = 127$) Figure 1. The characteristics of the patients are shown in Table 1. There were no significant differences between the two groups in terms of the patients' baseline demographics, including age, sex, BMI, type of gallbladder disease, Hospital Anxiety and Depression Scale (HADS) score, or American Society of Anesthesiologists (ASA) score.

Primary outcome

The mean duration of gallbladder extraction was 43.56 ± 16.51 s in the SXP group and 45.78 ± 17.00 s in the SXP group. The mean duration of gallbladder extraction in the SXP group was shorter than that in the SXP group, but the difference was not statistically significant. Regarding the location of pain, 70 patients experienced subxiphoid incision pain in the SXP group and 43 patients in the SUP group; 13 patients experienced superumbilical incision pain in the SXP group, and 23 patients in the SUP group; and 20 patients experienced no obvious pain in the SXP group or 25 patients in the SUP group. These results were statistically

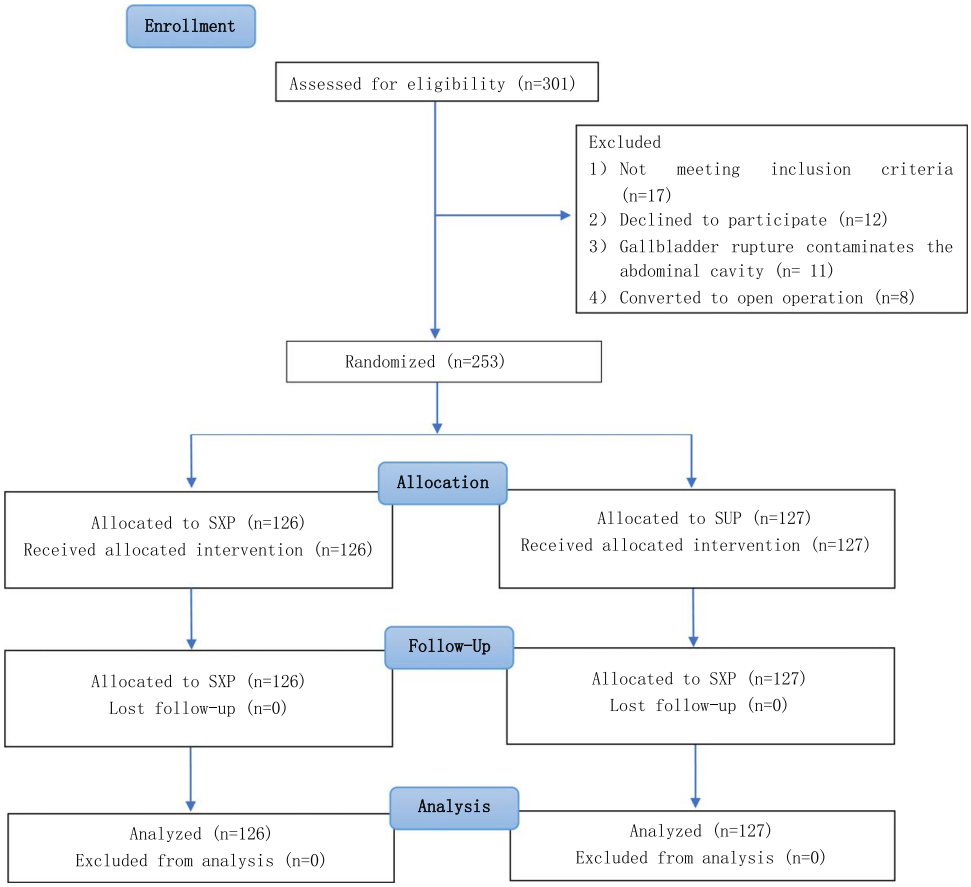

Figure 1. CONSORT flowchart.

Table 1

The background characteristics of patients between both groups.

Parameter	SXP ($n=126$)	SUP (127)	P
Age, mean ± SD [years]	40.79 ± 10.82	41.35 ± 10.46	0.675
Sex			
Male	56	43	0.085
Female	70	84	
BMI	23.53 ± 3.13	23.23 ± 3.17	0.452
Indication			
Gallbladder stone	97	107	0.062
Gallbladder polyp	28	16	
Gallbladder stone and polyp	1	4	
Single stone	21	19	0.429
Multiple stone	77	92	
Smoke	23	14	0.104
Drink	34	30	0.538
HADS scores			
Anxiety level			
Negative ≤7	67	60	0.626
8 ≤Mild ≤10	51	57	
11 ≤Moderate ≤14	8	10	
15 ≤Severe ≤21	0	0	
Depression level			
Negative ≤7	17	16	0.997
8 ≤Mild ≤10	84	86	
11 ≤Moderate ≤14	24	24	
15 ≤Severe ≤21	1	1	
ASA score			0.608
1	2	2	
2	124	124	
3	0	1	

ASA, American Society of Anesthesiologists; HADS, Hospital Anxiety and Depression scale.

Table 2

Comparison of outcomes and BPI between groups.

Parameter	SXP ($n=126$)	SUP ($n=127$)	P
Time of gallbladder extraction (s)	44 [34–55]	41 [30.75–53.25]	0.185
Extended incision	106	110	0.576
Location of pain			
Not pain	20	34	0.009
Subxiphoid incision	70	43	
Supraumbilical incision	13	23	
Right subcostal incision	20	25	
Shoulder or others	3	2	
Degree of pain			
The worst rate of pain	4.91 ± 2.45	4.24 ± 2.45	0.031
The least rate of pain	2.63 ± 1.61	2.51 ± 1.70	0.581
The average rate of pain	3.81 ± 2.01	3.35 ± 2.11	0.081
The right now rate of pain	3.06 ± 1.84	2.73 ± 1.92	0.173
Relief of pain (%)	65% [20–80%]	50% [10–80%]	0.121
< 50%	40	58	0.023
≥ 50	86	69	
Adding analgesics postoperation			
Yes	42	34	0.255
No	84	93	
Influence of pain			
General activity	4.51 ± 2.90	3.76 ± 2.92	0.041
Mood	3.62 ± 2.66	2.92 ± 2.36	0.028
Walking ability	4.40 ± 3.01	3.66 ± 2.76	0.044
Normal Work	5.06 ± 3.27	4.32 ± 3.43	0.078
Relations of other people	2.43 ± 2.13	2.13 ± 1.81	0.226
Sleep	4.11 ± 2.89	3.45 ± 2.73	0.062
Enjoyment of life	3.19 ± 2.68	2.32 ± 2.34	0.007
Complication			
Infection	2	4	0.414
Hernia	0	0	—

significant ($P=0.009$). The BPI score indicating the worst rate of pain in the SXP group was greater than that in the SUP group (4.91 ± 2.45 vs. 4.24 ± 2.45, $P=0.031$). The least rate of pain in the SXP group was greater than that in the SUP group, but there were no significant differences between the two groups (2.63 ± 1.61 vs. 2.51 ± 1.70, $P=0.581$). The average rate of pain in the SXP group was greater than that in the SUP group, but there were no significant differences between the two groups (3.81 ± 2.01 vs. 3.35 ± 2.11, $P=0.081$). The right now the rate of pain in the SXP group was greater than that in the SUP group, but there were no significant differences between the two groups (3.06 ± 1.84 vs. 2.73 ± 1.92, $P=0.173$). Forty-two patients received additional analgesics in the SXP group, and 34 patients received additional analgesics in the SUP group ($P=0.255$). More than 50% of patients in the SXP group and 58 in the SUP group experienced pain relief ($P=0.023$) (Table 2 and Figs. 1, 2). The patients' quality of life scores were recorded by the BPI (Table 2). The scores for general activity (4.51 ± 2.90 vs. 3.76 ± 2.92, $P=0.041$), mood (3.62 ± 2.66 vs. 2.92 ± 2.36, $P=0.028$), normal work (5.06 ± 3.27 vs. 4.32 ± 3.43, $P=0.078$), walking ability (4.40 ± 3.01 vs. 3.66 ± 2.76, $P=0.044$), relationships with other people (2.43 ± 2.13 vs. 2.13 ± 1.81, $P=0.226$), sleep (4.11 ± 2.89 vs. 3.45 ± 2.73, $P=0.062$), and enjoyment of life (3.19 ± 2.68 vs. 2.32 ± 2.34, $P=0.007$) in the SXP were greater than those in the SUP (Table 2 and Figs 3, 4).

On the third day, the VAS score was 3.75 ± 1.52 in the SXP group and 3.35 ± 1.57 in the SUP group ($P=0.045$). Fifty-five patients in the SXP group and 58 patients in the SUP group took off painkillers ($P=0.71$) Figure 4.

Secondary outcomes

Patients' VAS scores were also measured on the fifth day, the seventh day, and the fourteenth day; these results are shown in

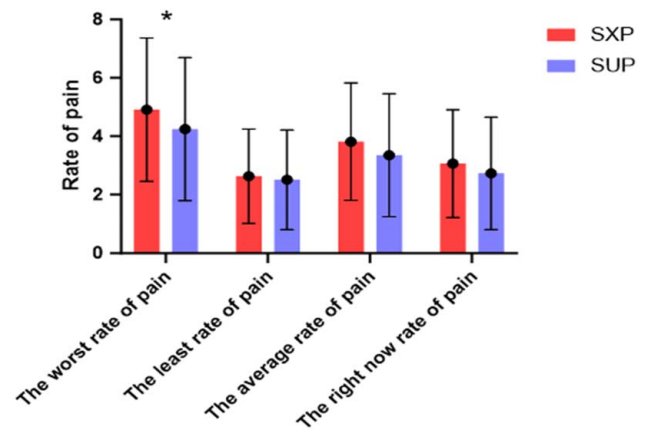

Figure 2. The multidimensional assessment of pain between SXP and SUP. SXP, supraumbilical port; SUP, subxiphoid port; * : $P < 0.05$.

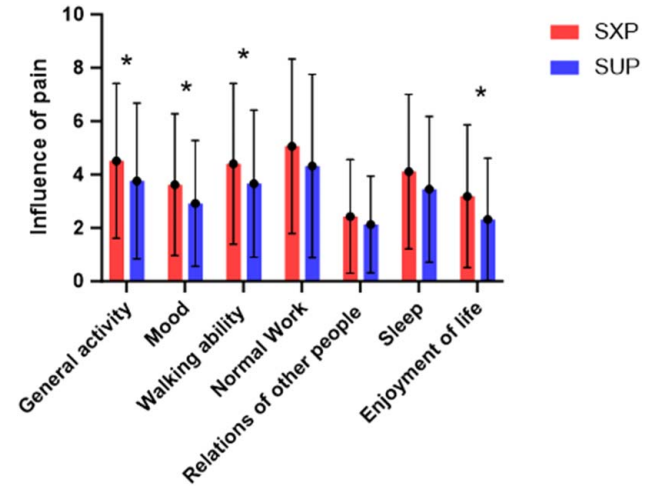

Figure 3. Quality of life scores influenced by pain between SXP and SUP. SXP, supraumbilical port; SUP, subxiphoid port; * : $P < 0.05$.

Table 3. The SXP group score was greater than the SUP group score, but there were no significant differences between the two groups Figure 4. Comparing the VSS of the two groups to that of the subxiphoid group, the color score of the SXP group was 1.62 ± 0.81 and 1.52 ± 0.87 in the SUP group ($P = 0.348$); the thickness of the SXP group was 0.94 ± 0.67 and 1.03 ± 0.70 in the SUP group ($P = 0.315$); the vascularity of the SXP group was 1.36 ± 0.86 and 1.31 ± 0.82 in the SUP group ($P = 0.637$); the softness of the SXP group was 1.54 ± 0.96 and 1.60 ± 0.95 in the SUP group ($P = 0.66$); and the total score of the subxiphoid scar was 5.46 ± 2.33 in the SXP group and 5.46 ± 2.46 ($P = 0.990$). Among the supraumbilical scars, the color score of the SXP group was 0.91 ± 0.72, and that of the SUP group was 0.94 ± 0.77 ($P = 0.796$); the thickness of the SXP group was 0.67 ± 0.61, and that of the SUP group was 0.68 ± 0.59 ($P = 0.889$); the vascularity of the SXP group was 0.80 ± 0.76, and that of the SUP group was 0.75 ± 0.70 ($P = 0.560$); the softness of the SXP group was 0.94 ± 0.79, and that of the SUP group was 0.87 ± 0.66 ($P = 0.441$); and the total score of the supraumbilical scar was 3.24 ± 2.07 ($P = 0.614$). All these data are shown in Table 4.

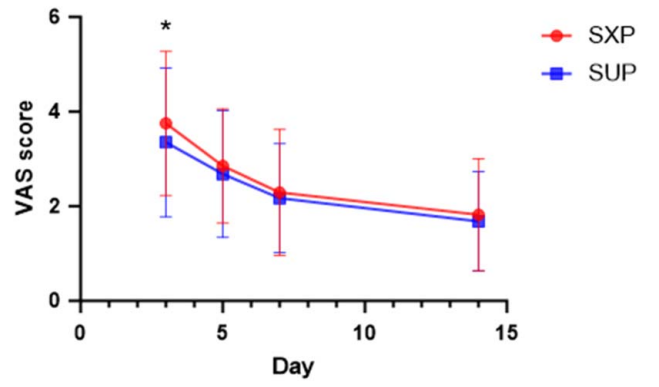

Figure 4. The postoperative VAS of patients between SXP and SUP. SXP, supraumbilical port; SUP, subxiphoid port; * : $P < 0.05$.

Table 3

The postoperative VAS of patients between the two groups.

Parameter	The most prominent pain region	SXP ($n = 126$)	SUP ($n = 127$)	P
Day3	Subxiphoid incision	95	82	0.060
	Supraumbilical incision	49	59	0.224
	VAS of Day3	3.75 ± 1.52	3.35 ± 1.57	0.045
	Take off painkiller	55	58	0.747
Day5	Subxiphoid incision	76	75	0.838
	Supraumbilical incision	46	51	0.551
	VAS of Day5	2.85 ± 1.21	2.68 ± 1.34	0.287
	Take off painkiller	40	47	0.403
Day7	Subxiphoid incision	69	59	0.186
	Supraumbilical incision	38	39	0.924
	VAS of Day7	2.29 ± 1.33	2.17 ± 1.15	0.442
	Take off painkiller	20	21	0.886
Day14	Subxiphoid incision	46	45	0.859
	Supraumbilical incision	29	35	0.406
	VAS of Day14	1.82 ± 1.18	1.68 ± 1.05	0.318
	Take off painkiller	5	4	0.748

Discussion

LC is currently the earliest and most widely used applied laparoscopic operation. Currently, LC has become a standard method for treating gallbladder diseases, such as gallbladder stones and other benign conditions.

However, postoperative pain is one of the main reasons for the unplanned return of patients with LC within 30 days[11]. The types of pain after LC generally include abdominal traumatic pain, visceral pain, and shoulder and back pain. Abdominal wall pain and visceral pain are predominant in the first 24–48 h after surgery. There are three reasons for pain: 1) an incision of tissue in the abdominal wall; 2) pneumoperitoneo-related pain, including local peritoneal and diaphragmatic tension; and 3) visceral pain after gallbladder dissection from the liver. It has been reported that incisional pain is more intense than visceral pain and is dominant during the first 48 h after LC[12]. Therefore, we believe that the type of port removed may be closely related to postoperative pain. In our study, our results showed that in the SXP group, the 24 h pain score of patients with the worst rate of pain was greater than that in the SUP group ($P = 0.026$). Although the least pain rate, average pain rate, and current pain rate did not significantly differ between the SXP group and the SUP group, the SXP group scores were greater than the SUP

Table 4

The postoperative VSS of patients between the two groups.

Incision	Parameter	SXP ($n = 126$)	SUP ($n = 127$)	P
Subxiphoid	Colour	1.62 ± 0.81	1.52 ± 0.87	0.348
	Thickness	0.94 ± 0.67	1.03 ± 0.70	0.315
	Vascularity	1.36 ± 0.86	1.31 ± 0.82	0.637
	Softness	1.54 ± 0.96	1.60 ± 0.95	0.626
	Total	5.46 ± 2.33	5.46 ± 2.46	0.990
Supraumbilical	Colour	0.91 ± 0.72	0.94 ± 0.77	0.796
	Thickness	0.67 ± 0.61	0.68 ± 0.59	0.889
	Vascularity	0.80 ± 0.76	0.75 ± 0.70	0.560
	Softness	0.94 ± 0.79	0.87 ± 0.66	0.441
	Total	3.24 ± 2.07	3.11 ± 1.95	0.614

group scores. Therefore, we believe that extracting the gallbladder from the SXP is less painful than extracting it from the SUP. Besides, according to Table 2, postoperative pain also influences patients' general activity, mood, walking ability, and enjoyment of life. These factors are correlated with patients' early postoperative mobility and affect their early postoperative recovery. In addition, we compared the VAS score on the third day, and the results showed that the SUP group scores were lower than those of the SXP group ($P = 0.042$). These results strongly proved that the rate of pain from taking off the gallbladder from the SUP was lower than that from the SUP.

Many previous studies have compared umbilical or epigastric port retrieval methods. Li *et al.*[9] reported that the rates of postoperative pain associated with the subxiphoid port and umbilical port were similar, but their results also showed that extraction of the gallbladder through the umbilical port could increase the risk of trocar site incisional hernia. However, other studies have shown that patients' pain in the subxiphoid port is more severe than that in the umbilical port. According to a recent meta-analysis, Aditya *et al.*[1] analyzed and concluded that there was no significant difference in postoperative VAS score at 24 h between umbilical or epigastric port retrieval. However, after we reviewed these studies, we found that some assessment measures were too simple; for example, they used VAS repeatedly, and the index was singular[13]. The samples were small, and the sizes of the stones were not classified. Therefore, in our study, our assessment indicators are more multidimensional when we use the BPI. The content of the assessment consisted of the highest level of pain, average pain level, the slightest degree of pain and whether life was influenced. Therefore, our study results were more multidimensional and more trustworthy because our samples are the largest among the present studies.

Trocar site incisional hernia (TSIH) is a common complication after Jordi *et al.*[4] and Gourav *et al.*[13] reported that the incidence of TSIH in the SUP was greater than that in the SXP, but Jordi's study was a retrospective analysis, and he did not classify the site of gallbladder removal. The formation of the TSIH is influenced by many factors, such as the muscle strength of the abdominal wall, patient nutrition, and trauma to the trocar site. The site at which the gallbladder was removed may also be a factor that causes hernia. The Gourav results showed that the incidence of hernia retrieval through the umbilical port was greater than that through the epigastric port. When large gallstones are removed, surgeons expand and pull incisions, which increases the risk of hernia. However, the difference was not statistically significant. In addition, SSI, obesity, and diabetes mellitus also contribute to the risk of developing TSIH[4,14].

The risk of SSI is also a factor in which surgeons choose which ports to remove the gallbladder. Jugendra *et al.*[15] showed that port-site infections occurred more frequently in the epigastric port than in the umbilical port. However, according to Kaya *et al.*[16] and Aditya *et al.*[1], port-site infection was more common in the umbilical port retrieval group, but according to the statistical analysis, there was no difference in port-site infections whether the gallbladder was removed from the umbilical or epigastric port. In this study, our results revealed no difference in infection between SXP and SXP.

Previous studies have reported that the subxiphoid port for gallbladder retrieval allows the surgeon to avoid adjusting the position of the camera and themselves, and it also results in lower wound complications and shorter operative time. These findings may lead many surgeons to prefer the subxiphoid port for gallbladder retrieval. In this study, we set a limit to the size of the stone, so removing the gallbladder was relatively easy, and factors that could influence the pain or complications of the incision or the duration of gallbladder extraction were decreased. That is maybe why the duration of gallbladder surgery was not different, and no hernias occurred after 1 month. However, it should be noted that a 1-month follow-up period may not be sufficient; longer follow-up, even up to 1–5 years, may be necessary.

Pain management does not depend solely on analgesics; it also includes anesthesia management, surgical procedures, and perioperative nursing. Previous studies have involved different operation procedures, small sample sizes, unclear stone sizes and less rigorous designs; therefore, strong evidence on which port is the best location according to the GB has not been provided. In this study, we designed rigorous RCTs and used multidimensional assessment indicators, which can help surgeons make better choices when removing GBs. Additionally, in addition to the location of GB retrieval, adjusting the pneumoperitoneum pressure and performing single-port LC could help patients decrease postoperative pain[11,17,18].

Conclusion

In summary, the extraction of the gallbladder via the SUP is superior to that via the SXP because the early postoperative 24 h pain and pain on the third day are mild and do not increase the duration of gallbladder extraction or the risk of infection or hernia. This study included the largest sample size and had a strict design, but we limited the size of the stones (< 1.2 cm), and we also lacked high BMI patients. In the future, we will start new RCTs and explore the effect of large stones when we remove the gallbladder.

Ethical approval

This study was approved by the clinic trial ethics committee of West China Hospital (2021-243).

Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

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Author contribution

Z.Y.: conception of the work; Y.M., D.B., Y.C., and Y.L.: data collections; X.Y., X.N., and H.L.: analyzed the data; X.Y. and X. N.: wrote the paper; X.Y., X.N., F.L., Z.Y.: revised the paper; Z.Y., F.L., and N.C.: contributed to the operations.

Conflicts of interest disclosure

The authors declare no conflict of interest.

Research registration unique identifying number (UIN)

1. Name of the registry: Chinese Clinical Trial Registry chictr.org.cn (http://www.chictr.org.cn/index.aspx).
2. Unique identifying number or registration ID: ChiCTR2100046408.
3. Hyperlink to your specific registration (must be publicly accessible and will be checked): (https://www.chictr.org.cn/showproj.html?proj=126629).

Guarantor

Zhen You.

Data availability statement

We agree provide our data of this study.

Provenance and peer review

Not commissioned, externally peer-reviewed.

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None.

Presentation

None.

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