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Influence of different peritoneal incision closure methods on the operative outcomes and prognosis of patients undergoing laparoscopic inguinal hernia repair.

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Keywords: Laparoscopic inguinal hernia repair; peritoneal rupture; bipolar coagulation.

Abstract. The aim was to investigate the effect of different peritoneal tear closure methods on the operative outcomes and prognosis of patients undergoing laparoscopic inguinal hernia repair (LIHR). Ninety patients who underwent LIHR in our hospital from August 2019 to December 2020 and had peritoneal tears during the operation were selected, and the patients were divided into a control group (CG) and the observation group (OG) according to different treatment plans, with 45 cases in each group. Patients in the CG were treated with absorbable sutures to repair the peritoneal tears, while patients in the OG were treated with bipolar coagulation to close and repair the peritoneal tears. The surgical conditions, postoperative pain scores, quality of life scores, complications, and recurrence were compared between the CG and OG groups. The operation time and hospital stay in the OG were shorter than those in the OG ($p<0.05$). The pain scores in the OG at 24 hours after operation were lower than those in the CG ($p<0.05$), and the pain scores of the two groups were not significantly different at two hours and 12 hours ($p>0.05$). Postoperative complications were not significantly different between the groups ($p>0.05$). The scores of material life, physical, social, and psychological function in the OG were higher than in the CG ($p<0.05$). There were no recurrences in the two groups during the 1-year follow-up. Closing repair of peritoneal rupture with bipolar coagulation reduces the operation time of patients with peritoneal rupture during TEP (total extraperitoneal hernioplasty) operations, reduces pain, and improves their quality of life. The treatment outcome is safe, effective, and has an excellent clinical application effect.

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Influencia de diversos métodos de cierre de la incisión peritoneal en los resultados quirúrgicos y el pronóstico en pacientes sometidos a reparación laparoscópica de hernia inguinal.

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Palabras clave: reparación laparoscópica de la hernia inguinal; ruptura peritoneal; coagulación bipolar.

Resumen. El propósito de este trabajo fue investigar el efecto de distintos métodos de cierre de desgarros peritoneales sobre el resultado quirúrgico y el pronóstico en pacientes sometidos a la reparación laparoscópica de hernia inguinal (LIHR). Fueron elegidos un total de 90 pacientes sometidos a LIHR en nuestro hospital desde agosto de 2019 a diciembre de 2020 y que tuvieron desgarros peritoneales durante la operación; los pacientes fueron divididos en un grupo control (GC) y un grupo de observación (OG) según distintos planes de tratamiento, con 45 casos en cada grupo. Los pacientes del GC fueron tratados con suturas absorbibles para reparar los desgarros peritoneales, mientras que los pacientes del OG fueron tratados con coagulación bipolar para cerrar y reparar los desgarros peritoneales. Se realizó una comparación de ambas condiciones quirúrgicas, que incluyeron las puntuaciones de dolor posoperatorio y calidad de vida, las complicaciones y la recurrencia entre los grupos GC y OG. El tiempo de operación e ingreso en el hospital en el OG fueron más cortos que en el OG ($p<0,05$). Las puntuaciones de dolor en el OG a las 24 horas después de la operación fueron menores que las del GC ($p<0,05$) y las puntuaciones de dolor de ambos grupos no fueron diferentes de modo significativo a las 2 horas y 12 horas ($p>0,05$). Las complicaciones postoperatorias no fueron significativamente diferentes entre OG ($p>0,05$). Los puntajes de vida material, función física, función social y función psicológica en el OG fueron más elevados que los del GC ($p<0,05$). No hubo recurrencias en ninguno de los grupos durante el seguimiento de 1 año. En conclusión, la reparación de cierre de la ruptura peritoneal con coagulación bipolar redujo el tiempo de operación de los pacientes, redujo su dolor y mejoró su calidad de vida. El efecto del tratamiento es seguro, efectivo y tiene un excelente resultado en su aplicación clínica.

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INTRODUCTION

An inguinal hernia is a common medical problem that develops when tissue, such as a portion of the intestine or abdominal fat, pushes through a weak area or hole in the abdominal wall [1]. This type of hernia is most common in men, but women can also develop them [2]. The lifetime risk of developing an inguinal hernia is 27-43% for men and 3-6% for women [3].

Inguinal hernias can be brought on by many things, such as heredity, age, persistent coughing, obesity, and physical stress[4,5]. Inguinal hernias often generate a visible bulge or swelling in the groin area, which

might become more noticeable while coughing or moving heavy things. The hernia may be painful or uncomfortable in certain circumstances, especially while standing or walking for extended periods [6,7].

Inguinal hernias can develop problems like incarceration or strangulation, in which the projecting tissue becomes trapped and loses blood flow, potentially resulting in tissue damage or even death. So, early diagnosis and treatment are essential in managing the condition and preventing complications [8].

Inguinal hernias are commonly treated with surgical repair, which may be done using laparoscopic or open methods. During surgery, the projecting tissue is pulled back into position, and the weak muscle wall is strengthened with sutures or synthetic mesh. Inguinal hernia surgery is frequently very successful and can offer long-lasting symptom alleviation [9,10].

However, during abdominal operations, peritoneal rips are a typical occurrence. Absorbable sutures and bipolar coagulation are two methods available to heal peritoneal injuries [11]. After a laparotomy or laparoscopy, the surgeon may close the peritoneum based solely on personal preference [12]. In order to minimize abdominal wall weakening and to prevent incisional hernias, it has been claimed by surgeons and in the standard surgical texts that the peritoneum should be sutured [13]. Nevertheless, clinical and experimental studies have shown that the raw peritoneal defect heals spontaneously, quickly, smoothly, and without apparent catastrophe because the peritoneum has no discernible impact on the healing process or the tensile strength of the laparotomy wound. So, after the laparoscopic hernia repair, the peritoneum should be left to heal spontaneously [14-16].

Since limited studies have compared these two techniques, and due to the existence of disagreements regarding the need to perform therapeutic measures and the need not to take action to repair the peritoneal rupture, this study was indicated to be conducted to compare the efficiency and safety of these two techniques and investigate the necessity or not of intervention in the repairment of peritoneal rupture during laparoscopic inguinal hernia surgery.

MATERIALS AND METHODS

General data

Ninety patients who underwent LIHR in our hospital from August 2019 to December 2020 and had peritoneal tears during the operation were selected and divided into the control group (CG) and the observation group (OG), with 45 cases in each group. The general data between the two groups was not significantly different ($p>0.05$) (Table 1). The ethics committee in the hospital approved this study, and all patients signed an informed consent form. Inclusion criteria: ①The age range considered for

Table 1
General data.

Groups	Cases	Sex		Age (years)	Disease course (months)	BMI (kg/m²)	Type (cases)			
		Male	Female				I	II	III	IV
Observation group	45	40 (88.8%)**	5 (11.12%)	63.56±7.76*	50.52±10.25	24.75±2.47	7 (15.5%)**	14 (31.1%)	13 (28.8%)	11 (24.6%)
Control group	45	38 (84.4%)	7 (15.6%)	62.23±7.85*	52.56±9.58	24.95±2.82	9 (20%)	12 (26.7%)	15 (33.3%)	9 (20%)
χ^2/t/Z		0.385		0.808	-0.975	-0.358	-0.377			
$p^{\&}$		0.535		0.421	0.332	0.721	0.706			

*Quantitative variables expressed by mean ± standard deviation. ** Qualitative variables expressed by frequency (percent). &P-value based on t-test / chi-square χ^2. *Significance level ≤ 0.05.*

this study was between 30 and 80 years old; ②Patients who were diagnosed with a direct inguinal hernia by clinical symptoms, signs, B-ultrasound, and other examinations[17], and who underwent TEP surgery and had peritoneal rupture during the operation; ③They fell within the American Society of Anesthesiologists grade I-II score; ④Patients with complete clinical medical records. Exclusion criteria: ①Patients with a history of mid-lower abdominal surgery; ②those with indirect inguinal hernia, incarcerated or strangulated hernia, or recurrent hernia; ③those with contraindications to general anesthesia; ④those with severe cardiac, hepatic, and renal dysfunction.

Operation methods

All patients received general anesthesia after entering the operating room. Surgeons performed all operations in the same group, and the specific operation steps strictly followed the "Guidelines for Standardized Operation of Laparoscopic Surgery for Inguinal Hernia". All patients were treated with TEP. In the observation group, a small incision of about 1.5 cm in length was made at 1 cm below the umbilicus to the line alba, followed by an incision of the skin, subcutaneous tissue, and anterior sheath of the *rectus abdominis*. The skin retractor was used to pull the *rectus abdominis* fiber to both sides until the posterior sheath was exposed, a one cm cannula was inserted, and the pneumoperitoneum was created. The other two five-mm cannulas were located five cm and ten cm below the median line umbilicus, respectively. The endoscope push method enlarged the preperitoneal space, and the pubic symphysis and the pubic ligament were exposed, turning laterally to isolate the Bogros space in the groin area.

After the direct hernia sac was freed and restored under direct vision, it was ligated at its base, and the distal end of the ligation line was cut off. The spermatic cord components were then abdominally walled, the iliac vessels were exposed, and the Bogros space in the groin area was fully exposed. The edge of the peritoneum cephalad was freed as much as possible to make room for patch placement. A 10 cm×15 cm polypropylene mesh was used as the repair material, and the mesh was rolled into a "cigarette" shape with the long axis as the edge and was placed in the casing. After entirely unfolding, the mesh was centered on the myopubic foramen to cover the inguinal foramen. The spermatic vessels and the *Vas deferens* were freed by 6 to 8 cm to expose the spermatic cord fully. The abdominal wall suture straight needle was used with No. 7 silk thread to enter the preperitoneal space twice; at the hernia ring, a needle thread and a needle and hook thread were successively passed on the patch, and the patch was subcutaneously fixed.

Peritoneal rupture closure methods

After the peritoneal rupture occurred during the operation, the peritoneum was closed by the corresponding methods: CG patients were treated with absorbable suture to repair the peritoneal tears, after entering the abdominal cavity, continuous suture with micro-wire or continuous suture was used with absorbable line, and then closed; while the patients in the OG were treated with bipolar coagulation to close and repair the peritoneal tears: the peritoneal rupture was repaired by bipolar electrocoagulation and hemostasis, and then the mesh was placed extraperitoneally.

Observation indicators

Operation situation

We observed and recorded both groups' operation time, intraoperative blood loss, and hospital stay.

Postoperative pain

At 2 h, 12 h, and 24 h after surgery, patients were evaluated using the visual analog scale (VAS) [18]. A 10 cm long straight line was used to show the degree of pain, and the scores ranged from 0 to 10 points, with 0 representing no pain and 10 as the most painful.

Complications

Patients' complications (including postoperative puncture hernia, intestinal fistula, intestinal obstruction, and chronic pain) were recorded.

Quality of life

The Comprehensive Assessment Questionnaire for Quality of Life (GQOL-74) [19] evaluated the patient's quality. Material life, physical function, social function, and psychological function were rated on a scale of 0 - 100 points, with higher scores being a better patient quality of life.

Recurrence conditions

The recurrence of hernia sac in the two groups after one year of treatment was recorded.

Statistical methods

SPSS 20.0 was used for statistical analysis, enumeration data were compared by X^2 test, rank data were compared by rank sum test, measurement data were expressed by mean±standard deviation ($\bar{x} \pm s$), and a *t*-test was used for comparison. The statistical result was regarded as statistically significant when $p<0.05$.

RESULTS

Comparison of operation conditions

The operation time and hospital stay in the OG were reduced compared to the CG ($p<0.05$), and in both groups, the intraoperative blood loss was not significantly different ($p>0.05$), as seen in Table 2.

Comparison of postoperative pain scores

The pain scores in the OG at 24 hours after the operation were reduced than those in the CG ($p<0.05$), and the pain scores at two hours and 12 hours in both groups were not significantly different ($p>0.05$), seen in Table 2.

Incidence of complications

The incidence of postoperative complications between the OG was not significantly different ($p>0.05$), as shown in Table 3.

Postoperative quality of life between the two groups

The scores of material life, physical function, social function, and psychological function in the OG were higher than those in the CG ($p<0.05$), as seen in Table 4.

Table 2
Operation conditions and postoperative pain scores in two groups.

Groups	Cases	Operation conditions			Postoperative pain scores		
		Operation time (min)	Intraoperative blood loss (mL)	Hospital stay (d)	Postoperative 2 h	Postoperative 12 h	Postoperative 24 h
Observation group	45	40.56±6.52*	24.45±4.74	3.54±1.22	3.58±1.34	2.27±0.75	1.20±0.28
Control group	45	60.35±10.74*	25.12±4.23	4.22±1.54	3.83±1.55	2.43±0.68	1.43±0.30
t		-10.566	-0.708	-2.322	-0.819	-1.060	-3.760
p[&]		0.001	0.471	0.023	0.415	0.292	0.001

*Quantitative variables expressed by mean ± standard deviation.
[&]P-value based on t-test. *Significance level* ≤ 0.05.

Table 3
Incidence of complications between the two groups.

Groups	Cases	Postoperative Puncture hernia	Intestinal fistula	Intestinal obstruction	Chronic pain	Total
Observation group	45	0 (0.00) *	0 (0.00)	1 (2.22)	1 (2.22)	2 (4.44)
Control group	45	1 (2.22) *	2 (4.44)	0 (0.00)	2 (4.44)	5 (11.11)
χ^2						0.620
$p^{\&}$						0.431

* Qualitative variables expressed by frequency (percent). &P-value based chi-square χ^2. *Significance level* ≤ 0.05.

Table 4
Postoperative quality of life between the two groups.

Groups	Cases	Psychological function	Social function	Physical function	Material life
Observation group	45	72.40±6.45*	75.62±5.46	77.46±6.72	73.46±6.85
Control group	45	67.58±7.52*	70.32±7.14	73.34±5.76	68.63±7.03
t		3.264	3.956	3.123	3.301
$p^{\&}$		0.002	0.000	0.002	0.001

*Quantitative variables expressed by mean ± standard deviation. &P-value based on t-test. *Significance level* ≤ 0.05.

Comparison of postoperative quality of life between the two groups

There were no recurrences in the two groups during a one-year follow-up.

DISCUSSION

Laparoscopic inguinal hernia repair has become increasingly popular due to its minimally invasive nature, faster recovery times, and lower postoperative complications than open surgical methods. The peritoneal incision's closure, which might affect the patient's recovery and general prognosis, is a crucial component of this treatment. The two main methods for closing the peritoneal incision are bipolar coagulation and absorbable sutures [11,20]. This study compared the operative outcomes and prognosis of patients undergoing laparoscopic inguinal hernia repair with these two different peritoneal incision closure methods.

This bipolar coagulation during TEP operation (OG) offers several advantages compared to the absorbable suture method (CG). The results showed a significantly shorter operation time and hospital stay, reduced pain scores at 24 hours' post-operation, and improved quality of life in various aspects for patients in the OG. Importantly, no significant difference was observed in the incidence of postoperative complications between the groups, indicating that the bipolar coagulation method is safe and effective.

The findings of this study are consistent with previous research, which has reported various benefits of using bipolar coagulation for the repair of peritoneal rupture. The study's results by Meyer *et al.* [21], showed that the rate of complications in the TEP method is low, and this laparoscopic hernia repair technique is repeatable and reliable.

The bipolar coagulation sealing technology converts electrical energy into heat energy to dissolve and denature tissue proteins, resulting in a permanent lumen or ruptured tissue coagulation and closure effect [22,23]. This technology can safely close tissue bundles, ligaments, and blood vessels with a <0.7 cm [24] diameter. The peritoneal injury stimulates the release of cytokines, activates the coagulation cascade, and deposits fibrin as a temporary matrix [25]. When bipolar electrocoagulation sealing technology is used to repair peritoneal ruptures, it rapidly dissolves and denatures fibrin and collagen to form new peritoneal tissue, resulting in a better sealing effect. Precautions should be taken during the operation to ensure the entire edge of the breach is closed, and the size of the bipolar energy and use time are critical to the closure effect [26]. The results of the study by Liang *et al.* [27], showed that compared with ultrasonic and bipolar electrocoagulation techniques, advanced bipolar use was more reliable for mesenteric vessels in laparoscopic surgery; however, bipolar electrocoagulation with optimal power can be used for its simplicity of operation and low cost. Various new electrosurgical devices will cause less damage as laparoscopic technology progresses, making surgery more accurate and less damaging. Although bipolar electrocoagulation has a broad thermal damage breadth, it is nevertheless relatively safe.

Oguz *et al.* [28], conducted a study to compare peritoneal closure techniques in laparoscopic transabdominal inguinal hernia repair. This study analyzed tucker and suture techniques to close the peritoneum based on the patient results. The results showed that tucker and suture have comparable safety for peritoneal closure in laparoscopic TAPP inguinal hernia surgery. However, what can be seen is that no study has simultaneously examined the variables of operation time and hospitalization, pain level, physical function, social function, and psychological function.

The results of our study showed that the use of bipolar coagulation reduces the operation time and hospitalization and also leads to a reduction in the pain score 24 hours after the operation. In addition, this study showed that patients who underwent closing repair with bipolar coagulation improved their scores in material life, physical functioning, social functioning, and psychological functioning, indicating an improvement in their overall quality of life.

The reduced operation time in the OG group can lead to increased patient satisfaction, decreased anesthesia-related complications, and reduced healthcare costs. Additionally, the shorter hospital stay observed in the OG group may further reduce healthcare costs and improve patient satisfaction.

The lower pain scores observed in the OG group may be attributed to the reduced tissue trauma and inflammation associated with bipolar coagulation compared to sutures [29]. This reduction in pain may contribute to a faster return to normal activities and improved postoperative quality of life.

The lack of significant differences in the incidence of postoperative complications between the two groups indicates that both methods are safe and effective in repairing peritoneal rupture. However, the improved quality of life scores in the OG group further emphasizes the potential benefits of the bipolar coagulation method.

Several factors can explain the preference for bipolar coagulation over spontaneous release of the peritoneum. Bipolar coagulation allows for better control of bleeding during the process, which can assist in shortening the operation time and lower the risk of complications [30]. Reduced operation time and bleeding can also contribute to a shorter hospital stay and lower pain scores, as observed in the study results.

Bipolar coagulation can accomplish hemostasis by denaturing proteins in the tissues, resulting in coagulation and closure of tiny blood vessels. This shortens the duration of the procedure by minimizing blood loss and lowering bleeding from the location of the peritoneal rupture. In contrast, spon-

taneous release of the peritoneum may result in ongoing bleeding from the rupture, lengthening the time needed for surgery [31].

Bipolar coagulation is a quick and simple technique that does not require suturing. It reduces operation complexity without compromising efficacy. In conclusion, bipolar coagulation is a simple and effective method for managing peritoneal rupture during TEP inguinal hernia repair with significant benefits over the spontaneous release of the peritoneum [32]; so, it should be considered as the first-line treatment option for this intraoperative complication.

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Conflict of interests

The authors declared that they have no competing interests.

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Contribution of authors

BZ played a crucial role in study design and conducted expertise in laparoscopic surgery. XL provided the statistical analysis and critical insights. CW contributed to the literature review and information synthesis. RZ conducted data collection and data analysis. XY contributed to the manuscript.

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