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**Influence of liver function after laparoscopy-assisted *vs* totally laparoscopic gastrectomy**



## INTRODUCTION

As a common tumor of the digestive system, gastric cancer (GC) has high morbidity and mortality rates. According to statistics from the International Agency for Research on Cancer (IARC), GC ranked fifth in incidence and fourth in mortality among new cancer patients worldwide in 2020[1].

Surgery is an indispensable part of the comprehensive treatment of GC. Total or distal gastrectomy (DG) with D2 lymphadenectomy is recommended for GC[2]. The commonly used radical gastrectomy for GC includes open gastrectomy (OG) and laparoscopic gastrectomy (LG). Compared with OG, LG is becoming more available in clinical practice, and it can be subdivided into total laparoscopic gastrectomy (TLG) and laparoscopic-assisted gastrectomy (LAG).

Previously, some studies have proposed that TLG is superior to LAG in terms of safety and feasibility based on the related intraoperative operative parameters and incidence of postoperative complications[3]. However, there are still few studies on the changes in postoperative liver function in patients undergoing LG. The present study compared the postoperative liver function of patients with TLG and LAG, aiming to explore whether there is a difference in the influence of TLG and LAG on the liver function of patients.

## MATERIALS AND METHODS

### *Patients*

The present study collected 80 patients who underwent LG from 2020 to 2021 at the Digestive Center (including the Department of Gastrointestinal Surgery and the

Department of General Surgery) of Zhongshan Hospital affiliated with Xiamen University, including 40 patients who underwent TLG and 40 patients who underwent LAG.

The inclusion criteria were as follows: patients were diagnosed with gastric carcinoma for the first time; patients had surgical indications for LG without obvious surgical contraindications; and the postoperative pathology was consistent with gastric carcinoma.

The exclusion criteria included patients with hepatitis B, hepatitis C, fatty liver, cirrhosis and other related basic diseases; patients with liver disease who underwent liver surgery; and patients with gallbladder and biliary tract diseases who underwent biliary system surgery[4].

***Operative methods***

After anesthesia, a conventional disinfection cloth was applied, and a trocar was placed in the 1 cm transverse incision below the umbilical region to establish pneumoperitoneum (12-15 mmHg). Laparoscopy was performed, and a trocar was placed in the left and right upper abdomen under direct vision to explore the entire abdominal cavity and determine the surgical method. The left liver was suspended with a fine line, and to release the greater omentum, part of the intestine and mesangium, the adhesion of the abdominal wall was observed. Surgical site dissociation and D2 lymph node dissection were performed with an ultrasonic scalpel and noninvasive forceps. A 60 mm cutting closure device was used in surgery.

TLG: The digestive tract was reconstructed in the lumen. The specimen was removed with a small incision of 4 cm in the umbilical section (Figure 1A and B).

ALG: Another 7 cm longitudinal incision was made in the middle of the lower abdomen of the xiphoid process. The left liver was pulled externally with an S-type retractor to expose the field of vision. Digestive tract reconstruction was completed under direct vision (Figure 1C).

### *Observations*

The levels of alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), γ-glutamyltransferase (GGLT), total bilirubin (TBIL), direct bilirubin (DBIL) and indirect bilirubin (IBIL) in the 2 groups were recorded before the operation, 1-2 d after the operation, 3-4 d after the operation, and 5-7 d after the operation. The normal range of the above test indices is as follows: ALT, 9-50 U/L; AST, 15-40 U/L; ALP, 45-125 U/L; GGLT, 10-60 U/L; TBIL, 5-21 μmol/L; DBIL, 0-4 μmol/L; and IBIL, 0-17 μmol/L.

### *Statistical analysis*

SPSS 26.0 was used for statistical analysis to compare whether the liver function-related indicators of the two groups before and after surgery were significantly different. Continuous data are expressed as mean ± SD and were analyzed by the independent *t* test. Categorical data are expressed as percentages and were analyzed by the chi-square test. A $P$ value < 0.05 was considered statistically significant.

## RESULTS

### *General*

Among the 40 patients who underwent TLG, there were 27 males and 13 females; 13 patients underwent total gastrectomy (TG), and 27 underwent DG, with an age of 64.63 year ± 8.40 year and a body mass index (BMI) of 22.45 kg/m$^2$ ± 3.90 kg/m$^2$. Among the 40 patients who underwent LAG, there were 26 males and 14 females, 19 patients who underwent TG and 21 patients who underwent DG, with an age of 64.78 year ± 9.50 year and BMI of 22.47 kg/m$^2$ ± 2.89 kg/m$^2$. There were no significant differences in sex, age, BMI or surgical resection extent between the 2 groups ($P$ > 0.05) (Table 1).

### *Transaminase*

The levels of preoperative ALT and AST were approximately the same in the 2 groups, both within the normal range; moreover, there was no significant difference in preoperative transaminase levels between the 2 groups ($P > 0.05$) (Table 2, Figure 2).

There were increases in the levels of ALT and AST from the preoperative value in the 2 groups on the 1st to 2nd d after the operation, and the increase was more significant in the LAG group, that is, approximately twice that of the TLG group. The ALT and AST levels in the TLG group were within the normal range, while the ALT and AST levels in the LAG group were beyond the normal range. There was a difference in transaminase levels between the 2 groups on the 1st to 2nd d after the operation ($P < 0.05$) (Table 2, Figure 2).

The ALT and AST levels in the 2 groups decreased on days 3-4 after surgery compared with days 1-2 after surgery, among which the levels in the TLG group had decreased to approximately the preoperative level and those in the LAG group had decreased to the normal value. There was a significant difference in the transaminase levels in the 2 groups on days 3-4 after surgery ($P < 0.05$) (Table 2, Figure 2).

The ALT and AST levels in the 2 groups showed little change on the 5th to 7th d after surgery compared with the 3rd to 4th d after surgery, presenting a general downward trend, both within the normal range, and there was a difference in the transaminase levels between the 2 groups on the 5th to 7th d after the operation ($P < 0.05$) (Table 2, Figure 2).

The 2 groups were further stratified according to TG or DG; that is, total laparoscopic TG (TLTG) was compared with laparoscopic-assisted TG (LATG), and total laparoscopic distal gastrectomy (TLGG) was compared with laparoscopic-assisted distal gastrectomy (LAGG). The overall change trend of transaminases between the TLTG group and the LATG, TLGG, and LAGG groups was approximately the same as that between the TLG and LAG groups. The preoperative transaminase levels in the TLTG group, LATG group, TLGG group and LAGG group were all within the normal range. The transaminase levels in the TLTG group, LATG group, TLGG group and LAGG group were increased 1-2 d after the operation, even beyond the normal range, and the

increase was more significant in the LATG group and LAGG group. Transaminase levels in the TLTG group, LATG group, TLGG group and LAGG group showed a declining trend on postoperative days 3-4 and 5-7 and gradually decreased to the preoperative level. At the same time, it was found that the transaminase levels in the TLTG group increased significantly compared with those in the TLGG group, and the transaminase levels increased significantly in the LATG group compared with the LAGG group. There were significant differences in transaminase levels between the TLTG group and the LATG group at 1-2 d after surgery and between the TLGG group and the LAGG group at 1-2 d after surgery, 3-4 d after surgery, and 5-7 d after surgery ($P < 0.05$), while there were no other significant differences ($P > 0.05$) (Table 3, Figure 3).

***Bilirubin***

The levels of TBIL, DBIL, and IBIL were roughly the same between the 2 groups before surgery and on day 1-2 after the operation, and all were within the normal range. There was no significant difference in bilirubin levels between the 2 groups before surgery and on day 1-2 after the operation ($P > 0.05$) (Table 4, Figure 4).

The levels of TBIL, DBIL, and IBIL on the 3$^{rd}$ to 4$^{th}$ d after the operation and IBIL on the 5$^{th}$ to 7$^{th}$ d after the operation in both groups were within the normal range, and the TLG group had higher levels than the LAG group. There were significant differences in bilirubin levels on the 3$^{rd}$ to 4$^{th}$ d after the operation and in the IBIL levels on the 5$^{th}$ to 7$^{th}$ d after the operation between the 2 groups ($P < 0.05$). There were no significant differences in the levels of TBIL and DBIL between the 2 groups on the 5$^{th}$ to 7$^{th}$ d after surgery ($P > 0.05$) (Table 4, Figure 4).

The 2 groups were further stratified according to TG or DG; that is, TLTG was compared with LATG, and TLGG was compared with LAGG. The overall change trend of bilirubin between the TLTG group and the LATG, TLGG and LAGG groups was roughly the same as that between the TLG and LAG groups. The bilirubin levels at all time points in each group were within the normal range. There were significant differences in bilirubin levels between the TLGG group and LAGG group 3-4 d after

surgery, in the indirect bilirubin levels between the TLGG group and LAGG group 5-7 d after surgery, and in the indirect bilirubin levels between the TLTG group and LATG group 3-4 d after surgery ($P < 0.05$). The bilirubin levels in the TLTG group and TLGG group increased significantly, while there were no other significant differences ($P > 0.05$) (Table 5).

### *Alkaline phosphatase and γ-glutamyltransferase*

The levels of ALP and GGLT in the 2 groups were approximately the same before surgery and 5-7 d after surgery, both within the normal range, with no significant difference ($P > 0.05$) (Table 6, Figure 5).

The ALP level on postoperative days 3-4 and the GGLT level on postoperative days 1-2 in the 2 groups were within the normal range. ALP in the TLG group was higher than that in the LAG group, and GGLT was higher than that in the TLG group, with significant differences ($P < 0.05$). There were no differences in ALP levels on the 1st to 2nd postoperative days or in the GGLT levels on the 3rd to 4th postoperative days between the 2 groups ($P > 0.05$) (Table 6, Figure 5).

The 2 groups were further stratified according to TG or DG; that is, TLTG was compared with LATG, and TLGG was compared with LAGG. The overall change trend of ALP and GGLT between the TLTG group and LATG group and between the TLGG group and LAGG group was roughly the same as that between the TLG group and LAG group. The ALP and GGLT levels at each time point in each group were within the normal range. There were significant differences in GGLT levels 1-2 d after the operation and in the ALP levels 3-4 d after the operation between the TLTG group and the LATG group ($P < 0.05$). The former levels were higher in the TLTG group, while the latter levels were higher in the LATG group, and there were no significant differences in the other groups ($P > 0.05$) (Table 7).

## DISCUSSION

Currently, studies have pointed out that LG has survival benefits similar to those of OG[5,6]. With the development of laparoscopic technology and the update and progress of surgical instruments, LG is becoming increasingly common in the clinic. However, TLG and LAG are still not clearly preferred in the clinic. Although relevant studies[7-11] have reported that TLG has advantages in many aspects, such as intraoperative dissection and postoperative recovery, the small incision in LAG also limits the intraoperative field of vision and operating space. However, TLG has higher requirements for surgical technique and operation coordination.

Comparative studies on the short-term therapeutic effect and long-term quality of life resulting from the 2 surgical methods have been completed, but there is still a lack of research on the postoperative liver function of patients receiving either of the 2 surgical methods. In this study, we found that in terms of transaminases, ALT and AST levels in the TLG group and the LAG group increased significantly after surgery; peaked on the $1^{st}$ to $2^{nd}$ d after surgery; gradually decreased, returning to the normal range on approximately the $3^{rd}$ to $4^{th}$ d after surgery; and then returned to the preoperative level on the $5^{th}$ to $7^{th}$ d after surgery. Among these values, the levels of ALT and AST in patients with LAG were significantly increased and beyond the normal range, and even the ALT and AST levels in patients with ALG were more than twice as high as those in patients with TLG on the $1^{st}$ to $2^{nd}$ d after surgery. Previous studies[12-15] have pointed out that $CO_2$ pneumoperitoneum reduces portal vein blood flow through intra-abdominal pressure and hypercapnia, thus causing liver function injury. In addition, both the TLG group and the LAG group underwent the operation of exposing the field of vision with liver traction by a fine line, and both groups underwent the operation of blocking the possible left vagal hepatic artery, which was the reason why the ALT and AST levels in the TLG group and the LAG group were higher than those before surgery. However, in this study, under the same $CO_2$ pneumoperitoneum conditions, the TLG group needed to complete all surgical steps under endoscopy, while the LAG group could complete digestive tract reconstruction under open conditions; that is, the effect of $CO_2$ pneumoperitoneum in the TLG group lasted longer than that in the LAG group.

However, the ALT and AST levels in the LAG group were higher than those in the TLG group; in other words, the postoperative liver function injury in the LAG group was higher than that in the TLG group, so the effect of $CO_2$ pneumoperitoneum was not considered the reason for the difference between the 2 groups. At the same baseline in this study, the difference between the TLG group and the LAG group was only due to differences in surgical methods. In the LAG group, a 7 cm longitudinal incision was made in the middle of the lower xiphoid, and the left liver was continuously pulled externally with the help of an S-type retractor to expose the field of vision during digestive tract reconstruction. Therefore, we considered that the operation of continuous squeezing and pulling of the liver with an S-type retractor was the main factor leading to the higher postoperative ALT and AST levels in the LAG group than in the TLG group. In addition, the 2 groups were further stratified according to TG or DG; that is, TLTG was compared with LATG, and TLGG was compared with LAGG. We found that the ALT and AST levels in the TLTG group were higher than those in the TLGG group, and the ALT and AST levels in the LATG group were higher than those in the LAGG group. Compared with DG, TG requires a more fully exposed field of vision for reconstruction of the digestive tract; that is, there is a higher degree of continuous squeezing and pulling of the left liver, which also confirms that continuous squeezing and pulling of the liver with an S-type retractor is the main factor leading to the difference in ALT and AST levels after surgery. Therefore, we considered that the higher postoperative transaminase level in the LAG group compared with the TLG group was caused by the different surgical methods; that is, the damage to liver function in the LAG group was greater than that in the TLG group. However, the levels of ALT and AST in the 2 groups recovered to the normal range approximately 3-4 d after surgery and returned to the preoperative level 5-7 d after surgery, indicating that the liver function injury was transient and reversible.

In this study, TBIL, DBIL, IBIL, ALP and GGLT levels at each time point in the 2 groups were all within the normal range. Between the 2 surgical methods, only the bilirubin levels on postoperative days 3-4, the indirect bilirubin levels on postoperative

days 5-7, the ALP levels on postoperative days 3-4, and the GGLT levels on postoperative days 1-2 were significantly different, while the changes in TBIL, DBIL, IBIL, ALP, GGLT, and other indicators showed no obvious regularity. Among them, the GGLT level in the TLG group was higher than that in the LAG group on the 1st to 2nd d after the operation, which was similar to the changes in postoperative transaminase in the 2 groups. Although the ALP level in the LAG group was higher than that in the TLG group 3-4 d after surgery, the postoperative ALP level in the 2 groups remained unchanged or decreased compared with the preoperative ALP level, which was similar to the results of Singal *et al*[16] in comparing liver function after laparoscopic cholecystectomy and open cholecystectomy. In addition, the levels of bilirubin in the TLG group on days 3-4 after surgery and the levels of indirect bilirubin in the TLG group on days 5-7 after surgery were higher than those in the LAG group. Relevant studies by Zhang *et al*[3] have pointed out that TLG patients exhaust for the first time earlier than LAG patients; therefore, we believed that TLG enables exhaust earlier than LAG does and restores intestinal function faster, thus opening the enterohepatic circulation, and bilirubin circulates into the blood through the portal vein. As a result, the postoperative bilirubin level in the TLG group was higher than that in the LAG group. Certainly, further clinical studies are required to confirm these findings.

The limitation of this retrospective study lies in the fact that the digestive center of Zhongshan Hospital Affiliated to Xiamen University included gastrointestinal surgery and general surgery. Therefore, the 40 patients with TLG and 40 patients with LAG in this retrospective study may be from different surgical treatment groups, which means that there are deviations in the surgical process caused by the difference in operational level of the operators. In addition, different surgical groups may also lead to certain differences in the diagnosis and treatment protocols adopted after surgery. For example, patients undergoing TLG resume enteral nutrition path earlier, enterohepatic circulation is opened, bilirubin circulates into the blood through the portal vein, and postoperative transient increase of bilirubin. This may also be the reason why the level

of bilirubin on days 3-4 after surgery and indirect bilirubin on days 5-7 after surgery are both higher in the patients undergoing TLG.

## CONCLUSION

In conclusion, both TLG and LAG can affect liver function, and this effect is transient and reversible. The effect of LAG on liver function is more serious. TLG is not only superior to LAG in terms of short-term efficacy and long-term quality of life but also in terms of liver function protection. Although TLG is more difficult to perform, it may be a better choice in radical gastrectomy.

**Figure 1 Liver traction.** A: Liver traction by a fine line; B: Abdominal incision in the totally laparoscopic gastrectomy (TLG) group; C: Liver traction by an S-type retractor and Abdominal incision in the another 7 cm longitudinal incision (ALG) group.

**Figure 2 Comparison of transaminase levels in each group.** A: B:

**Figure 3 Hierarchical comparison of transaminases in each group.** A: B: C: D:

**Figure 4 Comparison of bilirubin in each group.**A: B: C:

**Figure 5 Comparison of other liver function indicators in each group.** A: B: C:

**Table 1 Comparison of the general situation in each group**

| Variable | TLG group ($n$ = 40) | ALG group ($n$ = 40) | $t$ value | $P$ value |
|---|---|---|---|---|
| Age (yr) | 64.63 ± 8.40 | 64.78 ± 9.50 | 0.075 | 0.941[Nonsig] |
| BMI (kg/m$^2$) | 22.45 ± 3.90 | 22.47 ± 2.89 | 0.020 | 0.984[Nonsig] |
| M/F (case) | 27/13 | 26/14 | 0.056 | 0.813[Nonsig] |
| TG/GG (case) | 13/27 | 19/21 | 1.875 | 0.171[Nonsig] |

TLG: Totally laparoscopic gastrectomy; ALG: Another 7 cm longitudinal incision; BMI: Body mass index; TG: Total gastrectomy.

**Table 2 Comparison of transaminase levels in each group**

| Variable | TLG group ($n$ = 40) | ALG group ($n$ = 40) | $t$ value | $P$ value |
|---|---|---|---|---|
| ALT (U/L) | | | | |
| BO | 17.98 ± 11.44 | 16.28 ± 8.24 | 0.763 | 0.448[Nonsig] |
| AO | | | | |
| 1-2 d | 33.54 ± 15.28 | 72.49 ± 58.70 | 4.061 | < 0.001[Sig] |
| 3-4 d | 19.02 ± 8.18 | 32.03 ± 25.27 | 3.099 | 0.003[Sig] |
| 5-7 d | 21.18 ± 10.13 | 28.90 ± 17.20 | 2.447 | 0.017[Sig] |
| AST(U/L) | | | | |
| BO | 20.47 ± 5.88 | 20.56 ± 5.97 | 0.068 | 0.946[Nonsig] |
| AO | | | | |
| 1-2 d | 39.02 ± 14.67 | 85.27 ± 79.95 | 3.598 | 0.001[Sig] |
| 3-4 d | 17.99 ± 8.38 | 26.94 ± 19.35 | 2.684 | 0.010[Sig] |
| 5-7 d | 20.59 ± 8.64 | 26.16 ± 14.52 | 2.084 | 0.040[Sig] |

TLG: Totally laparoscopic gastrectomy; ALG: Another 7 cm longitudinal incision; BO: Before the operation; AO: After the operation; ALT: Alanine aminotransferase; AST: Aspartate aminotransferase.

**Table 3 Hierarchical comparison of transaminases in each group**

| Variable | TLTG group ($n$ = 13) | LATG group ($n$ = 19) | TLGG group ($n$ = 27) | LAGG group ($n$ = 21) | $P$ value |
|---|---|---|---|---|---|
| ALT (U/L) | | | | | |
| BO | 17.50 ± 8.85 | 13.94 ± 6.47 | 18.21 ± 12.65 | 18.39 ± 9.21 | 0.198[1,Nonsig], 0.956[2,Nonsig] |
| AO | | | | | |
| 1-2 d | 39.60 ± 16.03 | 93.41 ± 77.54 | 30.63 ± 14.31 | 53.57 ± 22.72 | 0.008[1,Sig], < 0.001[2,Sig] |
| 3-4 d | 20.93 ± 10.11 | 36.93 ± 31.96 | 18.10 ± 7.10 | 27.60 ± 16.80 | 0.092[1,Nonsig], 0.023[2,Sig] |
| 5-7 d | 24.82 ± 11.65 | 28.99 ± 15.59 | 19.42 ± 9.03 | 28.81 ± 18.91 | 0.419[1,Nonsig], 0.045[2,Sig] |
| AST (U/L) | | | | | |
| BO | 20.52 ± 5.96 | 20.13 ± 7.21 | 20.44 ± 5.96 | 20.94 ± 4.72 | 0.874[1,Nonsig], 0.754[2,Nonsig] |
| AO | | | | | |
| 1-2 d | 48.78 ± 13.56 | 112.37 ± 104.91 | 34.33 ± 12.94 | 60.74 ± 35.04 | 0.017[1,Sig], 0.003[2,Sig] |
| 3-4 d | 20.44 ± 10.63 | 24.96 ± 13.41 | 16.81 ± 6.99 | 28.74 ± 23.70 | 0.318[1,Nonsig], 0.036[2,Sig] |
| 5-7 d | 24.43 ± 8.54 | 24.49 ± 9.71 | 18.74 ± 8.20 | 27.66 ± 17.92 | 0.986[1,Nonsig], 0.044[2,Sig] |

[1]Total laparoscopic total gastrectomy group compared with the laparoscopic-assisted total gastrectomy group;

[2]Total laparoscopic distal gastrectomy group compared with the laparoscopic-assisted distal gastrectomy group.

TLTG: Total laparoscopic total gastrectomy; LATG: Laparoscopic-assisted total gastrectomy; LAGG: Laparoscopic-assisted distal gastrectomy; BO: Before the operation; AO: After the operation; ALT: Alanine aminotransferase; AST: Aspartate aminotransferase.

**Table 4 Comparison of bilirubin in each group**

| Variable | TLG group ($n$ = 40) | ALG group ($n$ = 40) | $t$ value | $P$ value |
|---|---|---|---|---|
| TBIL (umol/L) | | | | |
| BO | 13.44 ± 6.57 | 11.62 ± 4.85 | 1.409 | 0.163Nonsig |
| AO | | | | |
| 1-2 d | 15.05 ± 7.10 | 15.11 ± 7.27 | 0.042 | 0.967Nonsig |
| 3-4 d | 17.38 ± 8.44 | 11.65 ± 6.72 | 3.358 | 0.001Sig |
| 5-7 d | 15.26 ± 5.91 | 12.82 ± 6.70 | 1.728 | 0.088Nonsig |
| DBIL (umol/L) | | | | |
| BO | 2.40 ± 1.05 | 2.15 ± 0.99 | 1.074 | 0.286Nonsig |
| AO | | | | |
| 1-2 d | 3.74 ± 1.73 | 3.79 ± 2.05 | 0.112 | 0.911Nonsig |
| 3-4 d | 4.63 ± 3.32 | 3.22 ± 2.03 | 2.286 | 0.025Sig |
| 5-7 d | 4.17 ± 2.31 | 4.05 ± 4.09 | 0.155 | 0.877Nonsig |
| IBIL (umol/L) | | | | |
| BO | 10.93 ± 5.58 | 9.47 ± 3.93 | 1.355 | 0.179Nonsig |
| AO | | | | |
| 1-2 d | 11.36 ± 5.68 | 11.33 ± 5.45 | 0.020 | 0.984Nonsig |
| 3-4 d | 12.75 ± 5.90 | 8.43 ± 5.02 | 3.530 | 0.001Sig |
| 5-7 d | 11.21 ± 4.17 | 8.77 ± 3.54 | 2.819 | 0.006Sig |

TLG: Totally laparoscopic gastrectomy; ALG: Another 7 cm longitudinal incision; TBIL: Total bilirubin; DBIL: Direct bilirubin; IBIL: Indirect bilirubin; BO: Before the operation; AO: After the operation.

**Table 5 Hierarchical comparison of bilirubin in each group**

| Variable | TLTG group ($n$ = 13) | LATG group ($n$ = 19) | TLGG group ($n$ = 27) | LAGG group ($n$ = 21) | $P$ value |
|---|---|---|---|---|---|
| TBIL (umol/L) | | | | | |
| BO | 16.65 ± 9.40 | 11.77 ± 5.85 | 11.90 ± 4.04 | 11.49 ± 3.89 | 0.080[1,Nonsig], 0.726[2,Nonsig] |
| AO | | | | | |
| 1-2 d | 16.53 ± 7.32 | 15.17 ± 9.32 | 14.33 ± 7.01 | 15.06 ± 4.98 | 0.662[1,Nonsig], 0.687[2,Nonsig] |
| 3-4 d | 19.62 ± 11.28 | 12.67 ± 8.17 | 16.30 ± 6.66 | 10.73 ± 5.11 | 0.052[1,Nonsig], 0.003[2,Sig] |
| 5-7 d | 16.69 ± 6.58 | 13.75 ± 8.33 | 14.57 ± 5.56 | 11.98 ± 4.84 | 0.295[1,Nonsig], 0.097[2,Nonsig] |
| DBIL (umol/L) | | | | | |
| BO | 2.83 ± 1.42 | 2.12 ± 1.44 | 2.19 ± 0.76 | 2.18 ± 0.86 | 0.131[1,Nonsig], 0.969[2,Nonsig] |
| AO | | | | | |
| 1-2 d | 3.97 ± 1.67 | 3.69 ± 2.44 | 3.63 ± 1.77 | 3.87 ± 1.67 | 0.722[1,Nonsig], 0.628[2,Nonsig] |
| 3-4 d | 4.78 ± 2.56 | 3.70 ± 2.46 | 4.56 ± 3.67 | 2.80 ± 1.48 | 0.237[1,Nonsig], 0.044[2,Sig] |
| 5-7 d | 4.65 ± 1.51 | 4.63 ± 5.38 | 3.93 ± 2.60 | 3.53 ± 2.44 | 0.987[1,Nonsig], 0.587[2,Nonsig] |
| IBIL (umol/L) | | | | | |
| BO | 13.48 ± | 9.65 ± 4.76 | 9.70 ± 3.42 | 9.30 ± 3.09 | 0.102[1,Nonsig], |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 8.09 | | | | | | | | 0.678[2,Nonsig] |
| AO | | | | | | | | | |
| 1-2 d | 12.56 | ± | 11.48 | ± | 10.78 | ± | 11.20 | ± | 0.454[1,Nonsig], |
| | 5.83 | | 7.10 | | 5.62 | | 3.54 | | 0.765[2,Nonsig] |
| 3-4 d | 14.83 | ± | 8.97 ± 6.07 | | 11.75 | ± | 7.94 ± 3.94 | | 0.034[1,Sig], |
| | 8.88 | | | | 3.57 | | | | 0.001[2,Sig] |
| 5-7 d | 12.38 | ± | 9.12 ± 4.33 | | 10.64 | ± | 8.45 ± 2.71 | | 0.066[1,Nonsig], |
| | 5.33 | | | | 3.46 | | | | 0.021[2,Sig] |

[1]Total laparoscopic total gastrectomy group compared with the laparoscopic-assisted total gastrectomy group;

[2]Total laparoscopic distal gastrectomy group compared with the laparoscopic-assisted distal gastrectomy group.

TLTG: Total laparoscopic total gastrectomy; LATG: Laparoscopic-assisted total gastrectomy; TLGG: Total laparoscopic distal gastrectomy; LAGG: Laparoscopic-assisted distal gastrectomy; TBIL: Total bilirubin; DBIL: Direct bilirubin; IBIL: Indirect bilirubin; BO: Before the operation; AO: After the operation.

**Table 6 Comparison of other liver function indicators in each group**

| Variable | TLG group ($n$ = 40) | ALG group ($n$ = 40) | $t$ value | $P$ value |
|---|---|---|---|---|
| ALP (U/L) | | | | |
| BO | 78.78 ± 16.73 | 76.10 ± 20.28 | 0.644 | 0.521[Nonsig] |
| AO | | | | |
| 1-2 d | 60.59 ± 14.26 | 59.86 ± 13.99 | 0.231 | 0.818[Nonsig] |
| 3-4 d | 65.40 ± 15.58 | 57.06 ± 13.76 | 2.539 | 0.013[Sig] |
| 5-7 d | 73.97 ± 17.62 | 64.77 ± 26.06 | 1.850 | 0.068[Nonsig] |
| GGLT (U/L) | | | | |
| BO | 28.06 ± 32.63 | 31.70 ± 28.05 | 0.536 | 0.593[Nonsig] |
| AO | | | | |
| 1-2 d | 20.46 ± 25.74 | 34.07 ± 26.10 | 2.347 | 0.021[Sig] |
| 3-4 d | 28.47 ± 29.22 | 24.11 ± 16.19 | 0.825 | 0.413[Nonsig] |
| 5-7 d | 50.66 ± 37.38 | 54.33 ± 39.28 | 0.428 | 0.670[Nonsig] |

TLG: Totally laparoscopic gastrectomy; ALG: Another 7 cm longitudinal incision; GGLT: γ-glutamyltransferase; ALP: Alkaline phosphatase; BO: Before the operation; AO: After the operation.

**Table 7 Hierarchical comparison of the other liver function indicators in each group**

| Variable | TLTG group ($n$ = 13) | LATG group ($n$ = 19) | TLGG group ($n$ = 27) | LAGG group ($n$ = 21) | $P$ value |
|---|---|---|---|---|---|
| ALP (U/L) | | | | | |
| BO | 83.63 ± 13.24 | 76.36 ± 25.15 | 76.44 ± 17.92 | 75.87 ± 15.27 | 0.348[1,Nonsig], 0.907[2,Nonsig] |
| AO | | | | | |
| 1-2 d | 59.95 ± 9.59 | 57.47 ± 15.06 | 60.89 ± 16.19 | 62.01 ± 12.93 | 0.604[1,Nonsig], 0.796[△, Nonsig] |
| 3-4 d | 68.39 ± 15.53 | 56.44 ± 15.68 | 63.96 ± 15.70 | 57.61 ± 12.12 | 0.042[1,Sig], 0.133[2,Nonsig] |
| 5-7 d | 83.56 ± 19.69 | 66.68 ± 31.49 | 69.35 ± 14.78 | 63.04 ± 20.63 | 0.097[1,Nonsig], 0.223[2,Nonsig] |
| GGLT (U/L) | | | | | |
| BO | 27.42 ± 30.31 | 33.03 ± 32.33 | 28.36 ± 34.25 | 30.50 ± 24.29 | 0.625[1,Nonsig], 0.809[2,Nonsig] |
| AO | | | | | |
| 1-2 d | 19.15 ± 19.42 | 37.11 ± 28.46 | 21.09 ± 28.61 | 31.32 ± 24.15 | 0.042[1,Sig], 0.196[2,Nonsig] |
| 3-4 d | 34.22 ± 36.82 | 26.34 ± 19.69 | 25.70 ± 25.12 | 22.10 ± 12.39 | 0.490[1,Nonsig], 0.500[2,Nonsig] |
| 5-7 d | 59.74 ± 34.97 | 56.77 ± 44.02 | 46.29 ± 38.34 | 52.13 ± 35.42 | 0.840[1,Nonsig], 0.592[2,Nonsig] |

[1]Total laparoscopic total gastrectomy group compared with the laparoscopic-assisted total gastrectomy group;

[2]Total laparoscopic distal gastrectomy group compared with the laparoscopic-assisted distal gastrectomy group.

TLTG: Total laparoscopic total gastrectomy; LATG: Laparoscopic-assisted total gastrectomy; TLGG: Total laparoscopic distal gastrectomy; LAGG: Laparoscopic-assisted distal gastrectomy; TLG: Totally laparoscopic gastrectomy; ALG: Another 7 cm longitudinal incision; GGLT: γ-glutamyltransferase; ALP: Alkaline phosphatase; BO: Before the operation; AO: After the operation.

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