Journal of Applied Veterinary Sciences, 10 (4): (2025) proof
ISSN: Online: 2090-3308, Print: 1687-4072
Journal homepage : https://javs.journals.ekb.eg

A Comparative Study Between Laparoscopic Subtotal and Total Cholecystectomy in Dogs

Norihito MIZUNO[1], Shozo OKANO[2]*
[1]Mizuno Animal Clinic, 1-6-9 Syouzi, Ama-city, Aichi, Japan
[2]Laboratory of Small Animal Surgery 2, School of Veterinary Medicine, Kitasato University, 35-1 Higashi 23 bancho, Towada, Aomori, Japan
*Corresponding Author: Shozo OKANO, E-Mail : okano@vmas.kitasato-u.ac.jp

ABSTRACT

Open cholecystectomy (OC) is the standard treatment for canine gallbladder disease, but laparoscopic total cholecystectomy (LC) has recently been introduced as a minimally invasive alternative. In human surgery, laparoscopic subtotal cholecystectomy (LSC) is employed when Calot's triangle dissection is difficult, but its efficacy in dogs remains unclear. We aimed to compare the surgical stress, biochemical changes, and perioperative outcomes of LC and LSC in clinically healthy dogs. Twelve healthy adult beagles were randomly assigned to LC (n=6; 3 male, 3 female, age 1.4 ± 0.2 y, BW 10.4 ± 0.9 kg) or LSC (n=6; 3 male, 3 female, age 1.5 ± 0.3 y, BW 10.5 ± 1.5 kg) groups. Operative time, serum C-reactive protein (CRP), white blood cell (WBC) and lymphocyte count, plasma cortisol, alanine aminotransferase (ALT), alkaline phosphatase (ALP), and total bilirubin (TB) were measured preoperatively and at multiple postoperative time points. Operative time was significantly longer in the LSC group than in the LC group (63.8 ± 14.2 vs. 34.7 ± 9.8 min, $p < 0.05$). Cortisol at 1 h postoperatively was lower in LSC, whereas CRP at day 7 was higher. Lymphocyte count at day 5 was higher in LSC, and WBC at day 7 was lower in LC ($p < 0.05$ for all). No significant intergroup differences were found in ALT, ALP, or TB, and no perioperative complications occurred. Although LSC resulted in a longer surgical time and higher CRP levels, it reduced cortisol levels in the early postoperative period and did not result in any significant intraoperative complications. Although these results were obtained using healthy beagle dogs, LSC may be an alternative to LC, especially when Calot's triangle dissection is difficult or there is a high risk of bile duct injury.

Original Article:

Received
Accepted
Published in

Keywords: Dogs; Gallbladder surgery; Laparoscopic subtotal cholecystectomy; Laparoscopic total cholecystectomy; Surgical invasiveness.

***J. Appl. Vet. Sci., 10(4)*: Proof**

INTRODUCTION

The standard treatment for canine gallbladder disease is open cholecystectomy (OC), and most epidemiological reports are also based on OC (**Jaffey *et al.*, 2019; Youn *et al.*, 2018**). Recently, however, laparoscopic total cholecystectomy (LC) has been introduced into veterinary practice due to improvements in facilities and equipment. In veterinary medicine, laparoscopic surgery is recognized as less invasive and associated with reduced postoperative pain compared with open surgery (**Haraguchi *et al.*, 2017; Davidson *et al.*, 2004**). LC in dogs has shown to be minimally invasive and to result in fewer serious complications (**Kanai *et al.*, 2018; Mayhew *et al.*, 2008**).

In human medicine, LC is already considered the standard procedure, accounting for approximately 90% of all cholecystectomies (**Sirinek *et al.*, 2016; Agrusa *et al.*, 2014; Jeong *et al.*, 2011**). After its introduction, the incidence of bile duct injury was about three times higher than with OC (0.5%), but with advances in laparoscopic technique, this rate has decreased and currently remains low at approximately (0.19%) (**Mangieri *et al.*, 2019**).

Although LC offers the advantages of minimal invasiveness and high patient compliance, performing LC in cases with cholecystitis and unclear anatomy around the gallbladder remains challenging, and the risk of bile duct injury is still significant (**Mangieri *et al.*, 2019**). LC involves dissection of Calot's triangle, bounded by the cystic duct, common hepatic duct, and inferior surface of the liver, to expose the cystic duct. The cystic artery is often located within Calot's triangle and is typically ligated and divided at this stage. In cases of severe cholecystitis or fibrosis, approaching Calot's triangle can be difficult, increasing the risk of bile duct or arterial injury during the procedure (**Purzner *et al.*, 2019**). To avoid such complications, conversion from LC to OC is not uncommon.

As an alternative, laparoscopic subtotal cholecystectomy (LSC) has been proposed in human surgery for cases where dissection of Calot's triangle is unsafe (**Roesch-Dietlen *et al.*, 2019; Tay *et al.*, 2019**). In LSC, the gallbladder is transected at the neck rather than the cystic duct and separated from the liver bed. If severe adhesions are present, part of the gallbladder wall may be left attached to the liver (**Shin *et al.*, 2016**). LSC has been reported to prevent serious complications such as bile duct injury, although minor complications such as bile leakage and wound infection may occur (**Roesch-Dietlen *et al.*, 2019**).

In human surgery, LSC is indicated when the anatomy of Calot's triangle is unclear or when there is a high risk of bleeding or bile duct injury, thereby avoiding conversion to open surgery. Similarly, in canine cases—particularly in severe inflammation due to gallbladder mucocele—subtotal cholecystectomy may reduce mortality. However, subtotal cholecystectomy is not commonly performed in dogs, and the procedure has not been well studied.

The purpose of this study was to explore the feasibility of laparoscopic subtotal cholecystectomy as an alternative in situations where laparoscopic total cholecystectomy is expected to be challenging.

MATERIALS AND METHODS

1. Animals

Twelve clinically healthy adult beagle dogs were used. Dogs were randomly assigned to the LC group (male 3, female 3, age 1.4 ± 0.2 y, BW 10.4 ± 0.9 kg) or LSC group (male 3, female 3, age 1.5 ± 0.3 y, BW 10.5 ± 1.5 kg). They were fed once daily, provided water ad libitum, and maintained under controlled light, temperature, and humidity. All dogs were fasted for 12 hours before surgery. The study was conducted in accordance with the Kitasato University Laboratory Animal Guidelines and approved by the Kitasato University Laboratory Animal Ethics Committee (No.10-078, 2010).

2. Anesthesia

Premedication consisted of atropine sulfate (0.025 mg/kg IV; Atropine®, Mitsubishi Tanabe Pharma Corporation, Osaka, Japan), midazolam (0.1 mg/kg IV; Dormicum®, Astellas Pharma Inc., Tokyo, Japan), and fentanyl (5 µg/kg IV; Fentanyl injection solution®, Daiichi Sankyo Propharma, Tokyo, Japan). Anesthesia was induced with propofol (6 mg/kg IV; Propofol® for Animals, Mylan Seiyaku Co., Ltd., Osaka, Japan), followed by tracheal intubation. Maintenance was with isoflurane (1.5-2.0 %; Isoflurane® for Animals, Mylan Seiyaku Co., Ltd., Osaka, Japan) (**Muir *et al.*, 2013**).

3. Pain management

In addition to the induction dose of fentanyl, a continuous rate infusion (CRI) of fentanyl (10 µg/kg/h IV) was administered intraoperatively, reduced to 5 µg/kg/h after surgery and continued until 6 hours postoperatively. Meloxicam (0.1 mg/kg SC; Metacam® 0.5% injection, Boehringer Ingelheim Animal Health Japan K.K., Tokyo, Japan) was given before surgery and once daily for 3 days postoperatively.

4. Surgical Technique

LC group: After a small incision near the xiphoid process, a Verses needle was inserted and the abdomen insufflated with CO_2 to 10 mmHg (UHI-2, Olympus Corporation, Tokyo, Japan). A 5-mm trocar was placed 1.5 cm to the right of the umbilicus, and additional trocars were positioned to form an isosceles triangle with the gallbladder as the apex. Gas was delivered to induce pneumoperitoneum 10 mmHg at flow rate about 1.0 L/min. The gallbladder was grasped and retracted, exposing the neck. The cystic duct and artery were identified, clipped, and divided. The gallbladder was detached from the liver bed using an ultrasonic coagulation device (SonoSurg-IU, Olympus Corporation, Tokyo, Japan) and removed through the third trocar site (**Fig. 1. A-D**). LSC group: After insufflation, three 5-mm and one 10-mm trocars were placed (**Alhamdany and Alkattan, 2019**). Gas was delivered to induce pneumoperitoneum 10 mmHg at flow rate about 1.0 L/min.

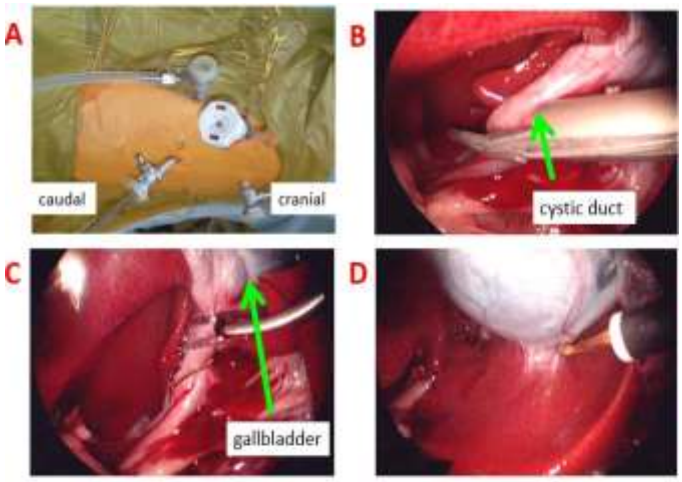


Fig.1: LC procedure: A) Trocar position, B) Ligation of the gallbladder duct and gallbladder artery with a clip applier, C) Three clips applied, D) Dissection of the gallbladder with an ultrasonic coagulation incision device. Complete removal of the gallbladder.

The gallbladder was grasped, and bile aspirated via a 23G catheter needle. The cystic duct was clipped without full Calot's triangle dissection. The gallbladder wall was divided using the ultrasonic device, leaving the portion adherent to the liver in situ, and the specimen was removed through the trocar site (**Fig.2.and Fig.3.A-D**).

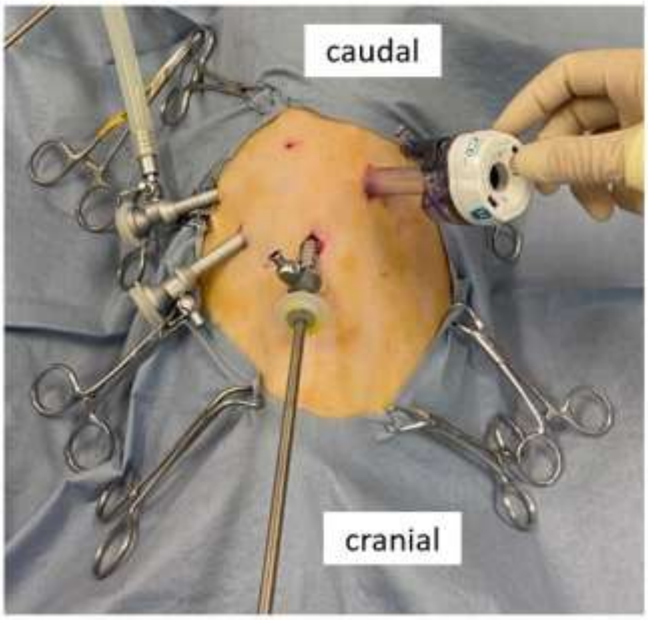


Fig.2: Location of trocars in the LSC group

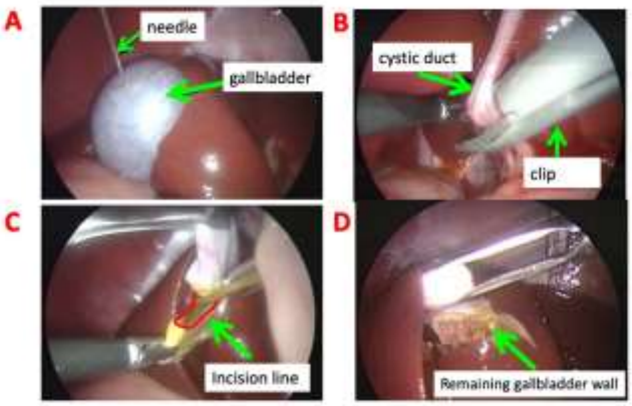


Fig.3: LSC procedure. A) Aspiration of bile with a catheterized needle, B) Ligation of the gallbladder duct and gallbladder artery with a clip applier, C) The gallbladder wall was removed using an ultrasonic coagulation incision device (red line), D) Residual posterior gallbladder wall after resection of the gallbladder wall.

5. Postoperative Care

Dogs were fed freely from the following day. All dogs received analgesics for 3 days and ampicillin (20 mg/kg IV, BID; Viccillin®, Meiji Seika Pharma, Tokyo, Japan) for 7 days postoperatively.

6. Measurement Items and Methods

Blood samples from the study dogs were collected preoperatively (pre), and at 1, 3, and 6 hours postoperatively, as well as on postoperative days 1, 3, 5, and 7. Samples were obtained from either the flexor cutaneous vein or the lateral saphenous vein and placed into EDTA, heparin, or serum tubes. Heparinized samples were centrifuged at 3,000 rpm for 5 minutes at 4°C, and the resulting plasma was frozen until analysis. Serum samples were centrifuged at 3,000 rpm for 10 minutes at 4°C, and the resulting serum was frozen and stored under the same conditions until analysis.

6.1. Measurement of Surgical Time

The operative time was defined as the duration from skin incision to completion of suturing.

6.2. Measurement of CRP

CRP concentrations were determined using a canine CRP assay by the immunoturbidimetric method (LaserCRP-2, Arrows Corporation, Osaka, Japan) in combination with a canine CRP reagent kit (Arrows, Arrows Corporation, Osaka, Japan). Measurements were performed according to the manufacturer's instructions. CRP was measured preoperatively (pre), at 1, 3, and 6 hours postoperatively, and on postoperative days 1, 3, 5, and 7.

6.3. Measurement of Cortisol Concentration

Cortisol concentrations were measured by a subcontracted clinical laboratory (SRL Corporation, Tokyo, Japan) using the ECLIA method. Measurements were taken preoperatively (pre), at 1, 3, and 6 hours postoperatively, and on postoperative days 1, 3, 5, and 7.

6.4. Determination of Total White Blood Cell Count and Lymphocyte Count

Total white blood cell counts were measured preoperatively (pre), at 1, 3, and 6 hours postoperatively, and on postoperative days 1, 3, 5, and 7 using an automated hematology analyzer (MEK-6558 Celltac α, Nihon Kohden Corporation, Tokyo, Japan). Lymphocyte counts were calculated from leukocyte differentials obtained from blood smear evaluations at each time point.

6.5. Measurement of ALT, ALP, and Total Bilirubin (TB) Concentrations

Plasma ALT, ALP, and TB concentrations were measured using an automated biochemical analyzer (Siemens Dimension RXL MAX, Siemens Japan K.K., Tokyo, Japan) preoperatively (pre), at 1, 3, and 6 hours postoperatively, and on postoperative days 1, 3, 5, and 7.

7. Statistical Analysis

Data are presented as mean ± standard deviation. Statistical analyses were performed using one-way analysis of variance (ANOVA), followed by Student's t-test or Welch's t-test. A p-value of <0.05 was considered statistically significant.

RESULTS

1. Operative Time

Mean operative time was significantly longer in the LSC group (63.8 ± 14.2 min) than in the LC group (34.7 ± 9.8 min, $p < 0.05$, **Fig.4**).

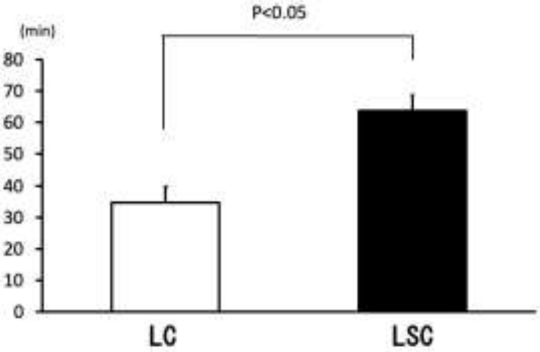


Fig.4: Comparison of surgical time between LC and LSC groups.

2. CRP

CRP was significantly lower in the LC group on postoperative day 7 ($p < 0.05$, **Fig.5 A**).

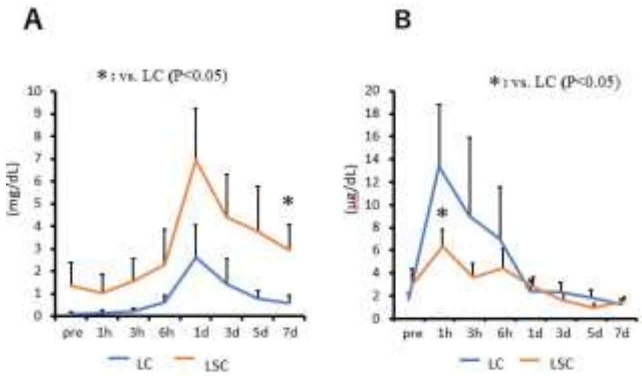


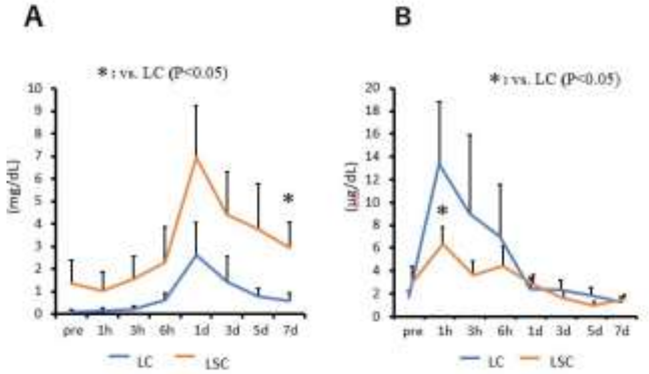
Fig.5: Comparison of CRP and Cortisol levels in the LC and LSC groups.A) CRP, B) Cortisol level

3. Cortisol

Cortisol was significantly lower in the LSC group at 1 h postoperatively ($p < 0.05$, **Fig. 5 B**).

4. WBC and Lymphocytes

WBC was significantly lower in the LC group on day 7 ($p < 0.05$, **Fig. 6 A**). Lymphocyte counts were significantly higher in the LSC group on day 5 ($p < 0.05$, **Fig. 6 B**).



ig.6: Comparison of Total white blood cell and Lymphocyte counts in the LC and LSC groups. A) Total white blood cell counts, B) Lymphocyte counts.

5. ALT, ALP, TB

` No significant differences between groups were observed (**Fig. 7 A-C**).

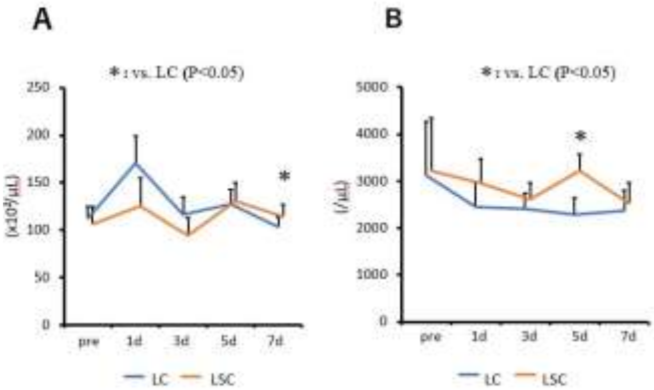


Fig.7: Comparison of ALT, ALP and TB in the LC and LSC groups.A) ALT, B) ALP, C) TB.

DISCUSSION

In this study, to compare the degree of surgical invasiveness between total cholecystectomy and subtotal cholecystectomy, we measured cortisol concentration, total white blood cell count, lymphocyte count, and CRP as indicators of surgical invasiveness (**Yamada *et al*., 2002; Prete *et al*., 2018; Matovic and Delibegovic, 2019; Khattak *et al*., 2022**). Postoperative cortisol concentrations were higher and lymphocyte counts were lower in the total cholecystectomy group compared to the subtotal cholecystectomy group. Total white blood cell counts tended to increase postoperatively in the total cholecystectomy group, but the difference was not statistically significant. These results suggest that subtotal cholecystectomy is less invasive than total cholecystectomy.

On the other hand, CRP levels were higher in the subtotal cholecystectomy group than in the total cholecystectomy group. This may be due to damage to the surrounding liver caused by the ultrasonic coagulation incision device during dissection of the gallbladder wall. Elevated CRP levels after laparoscopic subtotal cholecystectomy (LSC) compared to laparoscopic cholecystectomy (LC) have also been reported in humans, attributed to the greater complexity of the LSC procedure (**Jeong *et al*., 2011; Tamura *et al*., 2013**). In addition, bile leakage into the abdominal cavity during surgery in LSC may have induced bile leakage peritonitis. It has been reported that elevated CRP levels are effective in diagnosing bile leakage peritonitis (**Kianmanesh *et al*., 2025**). Since clinically healthy dogs were used in this experiment, dissection of the cystic triangle and gallbladder wall in total cholecystectomy was relatively easy, unlike in cases of cholecystitis. Therefore, it is possible that total cholecystectomy, involving gallbladder wall dissection, was more invasive than subtotal cholecystectomy.

Regarding ALT, ALP, and TB, there were no significant differences between the total and subtotal cholecystectomy groups; however, ALT and ALP increased postoperatively in all groups. In humans, elevated liver enzymes are common after LC without postoperative complications (**Halevy *et al*., 1994; Maleknia and Ebrahimi, 2020**), and transient increases in ALT are generally considered non-problematic in patients with normal liver function (**Halevy *et al*., 1994; Maleknia and Ebrahimi, 2020**).

Major complications of total cholecystectomy include bile duct injury and bleeding from vessels in the liver bed and around the gallbladder; thus, balancing benefits and risks of complete gallbladder removal is important. The main indication for total cholecystectomy in humans is acute cholecystitis, whereas in dogs it is gallbladder mucocele; the prevalence of cholecystitis in dogs with gallbladder mucocele is 28.8% (**Rogers *et al*., 2020**). If the potential complications of complete gallbladder removal are considered more serious than those of leaving a portion of the gallbladder, subtotal cholecystectomy may be preferred. While subtotal cholecystectomy can prevent massive bleeding and bile duct injury, concerns remain regarding bile leakage and severe inflammation of the residual gallbladder wall. In this study, only a small amount of bile leakage occurred during dissection of the gallbladder wall, and no complications from subtotal cholecystectomy were observed.

In humans, the posterior wall of the residual gallbladder is electrocauterized to prevent accumulation of secretions from residual mucosa (**Jeong *et al*., 2011**), but this was not performed in the present study.

No complications were observed after subtotal cholecystectomy in this study, suggesting that the procedure can be safely performed in dogs. Subtotal cholecystectomy may be a viable option in cases of severe cholecystitis or bile duct injury.

This study has limitations: healthy beagle dogs without liver dysfunction, coagulation abnormalities, or adhesions were used, allowing uncomplicated and rapid surgery. Additionally, long-term postoperative observation was not conducted. Further studies are needed to evaluate the clinical feasibility of subtotal cholecystectomy in veterinary medicine, including the incidence of complications.

In summary, laparoscopic subtotal cholecystectomy did not cause major perioperative complications and may be applicable in veterinary practice.

CONCLUSION

Although the results of this study were obtained using healthy beagle dogs, LSC may be an alternative to LC, especially when Calot's triangle dissection is difficult or there is a high risk of bile duct injury.

Acknowledgments

We thank Ms. Akiko Kurihara for her excellent technical assistance.

Conflict Of Interest

The authors declare no conflicts of interest regarding this article.

REFERENCES

AGRUSA, A., ROMANO, G., FRAZZETTA, G., CHIANETTA, D., SORCE, V., Di BUONO, G., and GULOTTA, G., 2014. Role and outcomes of laparoscopic cholecystectomy in the elderly. International Journal of Surgery, 12, Suppl 2, S37-S39. https://doi.org/10.1016/j.ijsu.2014.08.385

ALHAMDANY, M., and ALKATTAN, L., 2019. Laparoscopic and hand-assisted cystography strengthened with omental pedicle in dogs:

Radiographic and ultrasonographic study. Iraqi Journal of Veterinary Science, 33(2):347-52. https://doi.org/10.33899/ijvs.2019.163026

CREWS, L.J., FEENEY, D.A., JESSEN, C.R., ROSE, N.D. and MATISE, I. 2009. Clinical, ultrasonographic, and laboratory findings associated with gallbladder disease and rupture in dogs: 45 cases (1997-2007). Journal of American Veterinary Medical Association, 234(3), 359-366. https://avmajournals.avma.org/view/journals/javma/234/3/javma.234.3.359.xml

DAVIDSON, E.B., MOLL, H.D., and PAYTON, M.E., 2004. Comparison of laparoscopic ovariohysterectomy and ovariohysterectomy in dogs. Veterinary Surgery, 33(1), 62-69. https://doi.org/10.1111/j.1532-950X.2004.04003.x

HALEVY, A., GOLD-DEUTCH, R., NEGRI, M., LIN, G., SHLAMKOVICH, N., EVANS, S., COTARIU, D., SCAPA, E., BAHAR, M., and SACKIER, J.M., 1994. Are elevated liver enzymes and bilirubin levels significant after laparoscopic cholecystectomy in the absence of bile duct injury? Annals of Surgery, 219(4), 362-364. https://journals.lww.com/annalsofsurgery/abstract/1994/04000/are_elevated_liver_enzymes_and_bilirubin_levels.6.aspx

HARAGUCHI, T., KIMURA, S., ITOH, H., NISHIKAWA, S., HIYAMA, M., TANI, K., ISERI, T., ITOH, Y., NAKAICHI, M., TAURA, Y., and ITAMOTO, K., 2017. Comparison of postoperative pain and inflammation reaction in dogs undergoing preventive laparoscopic-assisted and incisional gastropexy. Journal of Veterinary Medical Science, 79(9), 1524-1531. https://doi.org/10.1292/jvms.17-0103

JAFFEY, J.A., PAVLICK, M., WEBSTER, C.R., MOORE, G.E., McDANIEL, K.A., BLOISl, S.L., BRAND, E.M., REICH, C.F., MOTOSCHENBACHER, L., HOSTNIK, E.T., SU, D., LIDBURY, J.A., RAAB, O., CARR, S.V., MABRY, K.E., FOX-ALVAREZl, W., TOWNSEND, S., PALERMO, S., NAKAZONE, Y., OHNO, K., and DeCLUE, A.E., 2019. Effect of clinical signs, endocrinopathies, timing of surgery, hyperlipidemia, and hyperbilirubinemia on outcome in dogs with gallbladder mucocele. Veterinary Journal, 251, 105350. https://doi.org/10.1016/j.tvjl.2019.105350

JEONG, I.O., KIM, J.Y., CHOE, Y.M., CHOI, S.K., HEO, Y.S., LEE, K.Y., KIM, S.J., CHO, Y.U., AHN, S.I., HONG, K.C., KIM, K.R., and SHIN, S.H., 2011. Efficacy and feasibility of laparoscopic subtotal cholecystectomy for acute cholecystitis. Korean Journal Hepato-biliary-Pancreatic Surgery, 15(4), 225-230. https://doi.org/10.14701/kjhbps.2011.15.4.225

KANAI, H., HAGIWARA, K., NUKAYA, A., KONDO, M., and ASO, T., 2018. Short-term outcome of laparoscopic cholecystectomy for benign gall bladder diseases in 76 dogs. Journal of Veterinary Medical Science, 80(11), 1747-1753. https://doi.org/10.1292/jvms.18-0266

KHATTAK, I.A., LQBAL, J., YOUNIS, S., HUSSAIN, S.A., RASHID, Z., and KHAN, M, S., 2022. Assessment of levels of CRP as a measure of stress response after open and laparoscopic cholecystectomy. Pakistan Journal of Health Sciences, 3(6), 203-206. https://doi.org/10.54393/pjhs.v3i06.307

KIANMANESH, R., AMROUN, K.L., RHAIEM, R., JAZI, A.H.D., MOAZENZADEH, H., RACHED, L., ZIMMERMANN, P., DURAME, A., RENARD, Y., RAVENET, A., BOUCHE, O., and DEGUELTE, S., 2025. C-reactive protein and digestive pathologies: A narrative review for daily clinical use. Journal of Research in Medical Science, 30, 10. https://doi.org/10.4103/jrms.jrms_537_23

MALEKNIA, S.A., and EBRAHIMI, N., 2020. Evaluation of liver function tests and serum bilirubin levels after laparoscopic cholecystectomy. Medical Archives, 74(1), 24-27. https://doi.org/10.5455/medarh.2020.74.24-27

MANGIERI, C.W., HENDREN, B.P., STRODE, M.A., BANDERA, B.C. and FALER, B.J. 2019. Bile duct injuries (BDI) in the advanced laparoscopic cholecystectomy era. Surgical Endoscopy, 33(3), 724-730. https://doi.org/10.1007/s00464-018-6333-7

MATOVIC, E., and DELIBEGOVIA, S., 2019. Adrenocorticotropic hormone (ACTH) and cortisol monitoring as stress markers during laparoscopic cholecystectomy: standard and low intraabdominal pressure and open cholecystectomy. Medical Archives, 73(4), 257-261. https://doi.org/10.5455/medarh.2019.73.257-261

MAYHEW, P.D., MEHLER, S.J., and RADHAKRISHNAN, A., 2008. Laparoscopic cholecystectomy for management of uncomplicated gallbladder mucocele in six. Veterinary Surgery, 37(7), 625-630. https://doi.org/10.1111/j.1532-950X.2008.00428.x

MUIR, W.W., HUBBELL, J.A.E., BEDNARSKI, R.M., and LERCHE, P., 2013. Handbook of Veterinary Anesthesia Fifth ed., Mosby Elsevier, St. Louis.

PRETE, A., YAN, Q., Al-TARRAH, K., AKTURK, H.K., PROKOP, L.J. ALAHI, F., FOSTER, M.A., LORD, J.M., KARAVITAKI, N., WASS, J.M., KARAVITAKI, N., WASS, J.A., MURAD, M.H., ARLT, W., and BANCOS, I., 2018. The cortisol stress response induced by surgery: A systematic review and meta-analysis. Clinical Endocrinology, 89(5), 554-567. https://doi.org/10.1111/cen.13820

PURZNER, R.H., HO, K.B., AL-SUKHNI, E., and JAYARAMAN, S., 2019. Safe laparoscopic subtotal cholecystectomy in the face of severe Inflammation in the cystohepatic triangle: a retrospective review and proposed management strategy for the difficult gallbladder. Canadian Journal of Surgery, 62(6), 402-411. https://doi.org/10.1503/cjs.014617

ROESCH-DIETLEN, F., PEREZ-MORALES, A.G., MARTINEZ-FERANDEZ, S., DIAZ-ROESCH, F., GOMEZ-DELGADO, J.A., and REMES-TROCHE, J.M., 2019. Safety of laparoscopic subtotal cholecystectomy in acute cholecystitis. experience in Southeast Mexico. Revista Gastroenterologia Mexico, 84(4), 461-466. https://doi.org/10.1016/j.rgmx.2018.11.012

ROGERS, E., JAFFEY, J.A., GRAHAM, A., HOSTNIK, E.T., JACOBS, C., FOX-ALVAREZ, W., VAN EERDE, E., ARANGO, J., WILLIAMS, F., and

DeClLUE, A.E., 2020. Prevalence and impact of cholecystitis on outcome in dogs with gallbladder mucocele. Journal of Veterinary Emergency Critical Care, 30(1), 97-101. https://doi.org/10.1111/vec.12910

SHIN, M., CHOI, N., YOO, Y., KIM, Y., KIM, S., and MUN, S., 2016. Clinical outcomes of subtotal cholecystectomy performed for difficult cholecystectomy. Annals of Surgical Treatment and Research, 91(5), 226-232. https://doi.org/10.4174/astr.2016.91.5.226

SIRINEK, K.R., WILLIS, R., and SCHWESINGER, W.H., 2016. Who will be able to perform open biliary surgery in 2025? Journal of American College of Surgeons, 223(1), 110-115. https://doi.org/10.1016/j.jamcollsurg.2016.02.019

TAMURA, A., ISHII, J., KATAGIRI, T., MAEDA, T., KUBOTA, Y., and KANEKO, H., 2013. Effectiveness of laparoscopic subtotal cholecystectomy: perioperative and long-term postoperative results. Hepatogastroenterology, 60(126), 1280-1283. https://doi.org/10.5754/hge13094

TAY, W.M., TOH, Y.J., SHELELAT, V.G., HUEY, C.W., JUNNARKAR, S.P., WOON, W. and LOW, J.K. 2019. Subtotal cholecystectomy: early and long-term outcomes. Surgical Endoscopy, https:/doi.org/10.1007/s00464-019-07242-7.

YAMADA, R., TSUCHIDA, S., HARA, Y., TAGAWA, M., and OGAWA, R., 2002. Apoptotic lymphocytes induced by surgical trauma in dogs. Journal of Anesthesia, 16(2), 131-137. https://doi.org/10.1007/s005400200008

YOUN, G., WASCHAK, M.J., KUNKEL, K., and GERARD, P.D., 2018. Outcome of elective cholecystectomy for the treatment of gallbladder disease in dogs. Journal of American Veterinary Medical Association, 252(8), 970-975. https://doi.org/10.2460/javma.252.8.970