Department of Companion Animals and Horses

University of Veterinary Medicine Vienna

Small Animal Surgery
(Head: Ass.-Prof. Dr.med.vet. Britta Vidoni)

Recumbencies for Laparoscopic Procedures in Dogs
A Systematic Review of the Current Literature

Lagerungen für laparoskopische Eingriffe bei Hunden
Ein systematisches Review der aktuellen Literatur

Diploma thesis

submitted by
Felix Widorn

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Academic advisor: Dr. med. vet. Lea Liehmann Dipl. ECVS
Clinical Unit of Small Animal Surgery of Vetmeduni Vienna
Department of Companion Animals and Horses
University of Veterinary Medicine Vienna

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List of Abbreviations

Abbreviation	
CO_2	Carbon dioxid
LAOHE	laparoscopically assisted ovariohysterectomy
NOTES	Natural Orifice Transluminal Endoscopic Surgery
OHE	ovariohysterectomy
OVE	ovariectomy
ORR	ovarian remnant removal

1. Introduction

1.1. History

Laparoscopic techniques have been used in human medicine for a long time and many operations would not be technically possible without these techniques. Minimally invasive surgical techniques have their origins in human medicine. The first attempts at endoscopic surgical technique began in the early 19th century with a candle as a light source. More advanced laparoscopic techniques and devices with different lenses were developed in the 1930s. The first studies on recumbencies were carried out during World War II. The first documented cases of laparoscopic operations on dogs occurred in the 1970s (Fransson and Mayhew 2015).

In general, one can say that veterinary medicine is a good twenty years behind human medicine. The first book on minimally invasive surgery was published in 1999 (Freeman 1999). In 2003 the “Veterinary Endoscopy Society” was founded by Dr. Eric Monnet.

In veterinary medicine, on the other hand, as in human medicine, its use is associated with high costs, which are simply more difficult to bear due to the lack of health insurance companies for pets. It is now possible for more and more veterinarians to train with laparoscopic instruments and use these devices and so there has been a strong urge to research in this area of curative medicine, especially since the turn of the millennium. Benefits are the magnified view of abdominal organs, reduced postoperative pain and many more (Richter 2001, Monnet and Twedt 2003)

1.2. Technique

There are three major parts in laparoscopic surgery:

1. Establishing pneumoperitoneum
2. Positioning of the patient
3. Port placement and number of ports

1.2.1 Establishing Pneumoperitoneum

In order to perform a laparoscopic operation, a space must first be created in the abdomen, which usually achieved with carbon dioxide (CO_2) insufflation to a certain pressure measured in mmHg. The capnoperitoneum can be attained, inter alia, with a Veress needle or via direct trocar insertion (Fransson and Mayhew 2015).

1.2.2 Positioning Of The Patient

Common positions are the dorsal or lateral recumbencies, also lateral tilted positions of the patient are frequently used. Another position, which is often used is the Trendelenburg position, where the patient is in dorsal position with the head tilted downwards and the tail upwards. The prerequisite for these positions is a tilting table, which enables the patient to be repositioned during the operation.

1.2.3 Port Placement And Number Of Ports

The choice of the number and position of the ports, together with the recumbency of the patient, represent the Alpha and Omega of laparoscopic surgery. There are single port techniques, where only one trocar is used, which has a single or multiple inputs for instruments. If this trocar has several entrances, it is called a “multiport”. There are also techniques in which more than one port is used, for example a "two-port technique", two separate accesses to the abdominal cavity are accomplished. A "three-port technique" has three entrances to the abdomen and so on.

1.3. Aim Of This Study

This diploma thesis discusses the various laparoscopic techniques in the abdomen of dogs and tries to give an overview of the last 20 years of science. It focuses mainly on the positioning of the patient, but also on the surgical access and the consequences for the surgeon. Additionally, the pressure of the insufflation was documented as well. The aim of the work is to summarize and discuss the results in order to identify gaps in science.

2. Materials And Method

The data were collected using MEDLINE and CAB Abstracts databases. The MEDLINE database was screened with Scopus and the CAB Abstracts database with CAB Direct.
All entries in the MEDLINE database were searched between the years 2000 and 2020 that contain the word "dog", the root word "laparoscop" in combination with the word stems "position" or "recumbenc". In the CAB Abstracts database a similar search has been put together. All records between the years 2000 and 2020, with the descriptor "Dog", which contain the word stem "laparoscop" in combination with the word roots "position" or "recumbenc", were screened.

Table 1: Criteria for inclusion/exclusion

Inclusion criteria	**Exclusion criteria**
English or German language	Not written in English or German
Published between 2000 and 2020	Published before 2000
Laparoscopic procedure	Book chapters
Recumbency described	Human studies
Ports described	Extraabdominal procedures
	Anesthesia studies
	Veress needle studies without an actual surgical procedure
	Laparotomy procedures
	Laparoscopic procedures with no information about recumbencies or port placement
	No access via the library
	NOTES procedures

The aim of the search was to collect as many articles as possible which contain information about the recumbencies and access ports. Subsequently, all publications that were not written in English or German, not published between 2000 and 2020, as well as human studies or book chapters, were manually excluded afterwards. Since the focus is on laparoscopic

abdominal procedures, laparotomy procedures, extraabdominal procedures, anesthesia papers and mere Veress needle studies were also excluded. Papers which fit the inclusion criteria but had no information about positioning of the patient or port placement were also excluded manually after the search. Procedures with the “Natural Orifice Transluminal Endoscopic Surgery“ technique (NOTES) were also excluded. Publications that were not accessible through the university library were also excluded.

Additionally, references of the papers with information about the consequences of port placement and recumbencies were screened. Titles with the keywords “laparoscopic“, “laparoscopy“ or the name of a laparoscopic procedure, such as “gastropexy” or “ovariectomy”, were again screened for information about port numbers, their location and recumbencies. Those that contained information about recumbencies, or ports were also included, otherwise excluded. Publications which couldn’t be accessed via the online access or prints of the library of the University of Veterinary Medicine Vienna were also excluded. All the criteria are listed in Table 1: *Criteria for inclusion/exclusion*

All papers were sorted in an Excel sheet by its procedures und summed up in the results. Important information was extracted into the tables in the results.

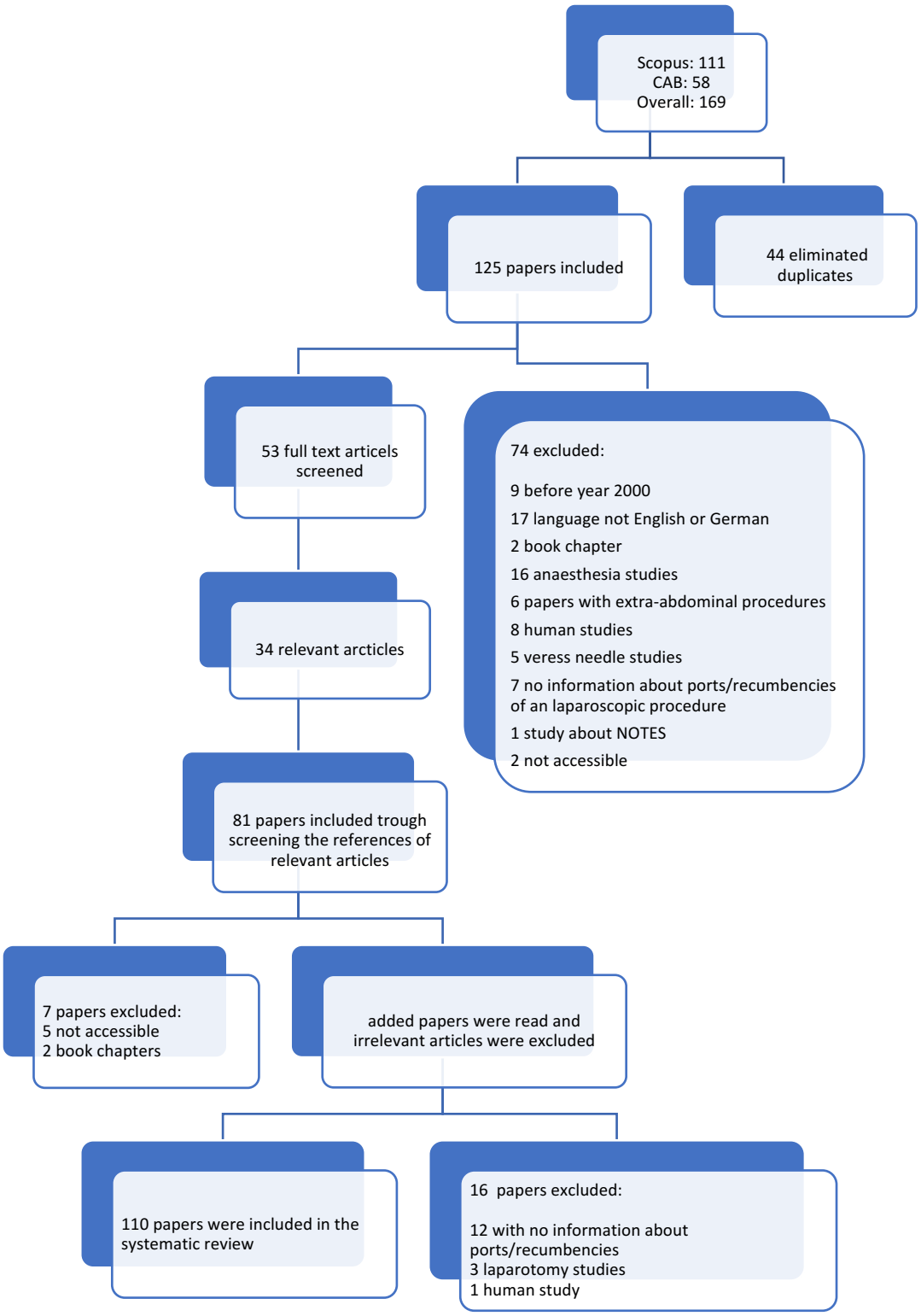

Figure 1:Flow chart of the literature search

A literature search was performed with Scopus as well as with CAB Direct on 31st December 2020. The combination of the search terms “TITLE-ABS-KEY (dog) AND TITLE-ABS-KEY (laparoscop*) AND (position* OR recumbenc*)” revealed 111 articles in the Medline searching with Scopus. With CAB Direct a number of 58 articles was yielded with the search path “(((od:("dogs") AND (de:("laparoscopy")) yr:[2000 TO 2020]) AND ((position* OR recumbenc*))”.

3. Results

A total of 169 articles were implemented in Zotero software (Roy Rosenzweig Center for History and New Media). The workflow can be seen in the Flowchart in Figure 1. Fourty-four duplicates were eliminated as well as nine additional articles due to their date of publication before the year 2000. Seventeen papers were excluded because they were not drafted in English or German. Sixteen anesthesia studies, six extra-abdominal and five Veress needle studies were also excluded. Seven laparoscopic articles with no information about recumbencies or ports as well as eight human studies were excluded. Fifty-three full text papers were screened for information about laparoscopic port numbers, location and recumbencies.

Screening the references of the relevant papers, another eighty-one titles were imported. Thereof twelve publications with no information about recumbencies or port placements were precluded, as well as two book chapters, one human article and three laparotomy studies. Also, five articles could not be accessed and were also not included in this review.

Ultimately 110 papers were included the evaluation for the review.

3.1. Abdominal Exploration

Table 2: Abdominal exploration

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Richter	2001	review	examination of liver and pancreas/kidney/ bladder and reproductive tract	Liver and Pancreas: left oblique (45°) Kidney: lateral (with affected side up) Bladder and reproductive tract: dorsal	Liver and Pancreas: telescope just below the lumbar muscles in the right flank Kidney: telescope caudal to the umbilicus and a few centimeters lateral to midline toward the kidney location of instrument port not described Bladder and reproductive tract: telescope halfway between the umbilicus and xiphoid, instrument port if needed lateral to it	<15
Maiti et al.	2008	case series	abdominal exploration	Trendelenburg recumbency (30°)	1-port technique: telescope port midline 2 to 4 cm cranial to the umbilicus 2-port technique: same telescope port, instrument port 5 to 7 cm lateral to the midline	10–12
Freeman	2009	review	abdominal exploration	Dorsal, lateral rotation during examination	-	-
Case and Ellison	2013	prospective case series	abdominal exploration	dorsal, 45° degrees to the side for guts	1-port technique: midline caudal to the umbilicus	10
Wright et al.	2016	retrospective study	abdominal exploration, splenectomy (lap ass.)	dorsal, (45° to the side for guts)	1-port technique: midline caudal to the umbilicus	8–10

Barry et al.	2017	controlled trial	abdominal exploration	dorsal, 45° to the side	1-port technique: midline caudal to the umbilicus	10
Shamir et al.	2019	retrospective study	abdominal exploration, biopsies	dorsal, 45° to the side	1-port technique: midline 1 cm caudal to the umbilicus 2-port technique (for biopsies): same telescope port, instrument port cranial or caudal to it or 2 to 4 cm lateral to the telescope port	8–12
Oramas et al.	2019	experimental study	liver exploration, tumor ablation	15° reverse Trendelenburg position, with 45° lateral rotation during examination of the liver	2-port technique: telescope port caudal to the umbilicus, instrument port a third of the distance cranial between the umbilicus and the xiphoid	12

Abdominal exploration is a basic procedure in laparoscopy to get an overview of organs and pathologies in the abdominal cavity. It is usually performed first, regardless of the type of laparoscopic procedure that follows. As in a laparotomy, after an access has been made, all internal organs are examined first. To enable organ visualization, various recumbencies are employed. After port placement (usually in dorsal recumbency), the dogs are maintained in dorsal recumbency to get an overview with a single multiport or a telescope port just caudal to the umbilicus (Freeman 2009, Case and Ellison 2013, Barry et al. 2017, Shamir et al. 2019). Barry et al. (2017) described a 45° tilted position to the left to evaluate the duodenum and the right limb of the pancreas, but they used a 45° tilted position to the right to examine the spleen, gastric fundus, the descending and transverse colon and the tip of the left limb of the pancreas. Dorsal recumbency is especially used for exploration of the liver, gallbladder and stomach (Barry et al. 2017). Shamir et al. (2019) also used 45° angles for better visualization, left oblique recumbency for the left abdominal gutter and right oblique for the right abdominal gutter. Also, forceps or probes were used to move the organs for better visualization (Shamir et al. 2019). For exploration of the duodenum a rotation to the left is described by Freeman (2009), a tilt to the right side and retraction of the descending colon exposes the left kidney, ovary and adrenal gland. For exploration of the liver lobes the 15° reverse Trendelenburg position provided a good view of the liver hilus. Also, 45° lateral rotation of the patient to the opposite of the

diseased lobe revised visualization (Oramas et al. 2019). In a review by Richter (2001) described a 45° oblique recumbency to the side for examination of the liver and the pancreas, with the telescope just below the lumbar muscles in the right flank. To examine the bladder and the reproductive tract a dorsal recumbency with the telescope port midway between the umbilicus and the xiphoid is delineated (Richter 2001).

A laterally tilted position of 45° rotation improved the view for exploration (Wright et al. 2016). A Trendelenburg position is also described with the telescope port midline and 2 to 4 cm cranial to the umbilicus (Maiti et al. 2008). For examination of the kidneys a lateral recumbency with the affected side up and telescope port caudal to the umbilicus and a few centimeters lateral to midline toward the kidney (Richter 2001) is described.

3.2. Ovariectomy

Table 3: Ovariectomy

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Goethem et al.	2003	clinical trial	ovariectomy	Trendelenburg, tilted to the side if necessary	3-port technique: midline telescope port halfway between the umbilicus and the pubis. Instrument portals: 1 cm caudal to the umbilicus and the cranial portal 1 cm cranial to the umbilicus and slightly paramedian	8–12
Van Nimwegen et al.	2005	prospective clinical trial	ovariectomy	Trendelenburg (10°)	3-port technique: midline telescope 1 cm caudal to the umbilicus. instruments: midline 1 cm cranial to the umbilicus and midway between the cranial edge of the pubis and umbilicus	8

Nickel et al.	2007	clinical study	ovariectomy	Trendelenburg or lateral tilted	3-port technique: telescope umbilical. Instrument portals: 3 to 6 cm cranial and caudal to it (caudal to the xiphoid process and cranial to the urinary bladder)	8 –10
Van Nimwegen and Kirpensteijn	2007	prospective clinical trial	ovariectomy	Trendelenburg (10°)	3-port technique: midline telescope 1 cm caudal to the umbilicus. Instrument portals: midline 1 cm cranial to the umbilicus and midway between the cranial edge of the pubis and umbilicus	8–10
Gower and Mayhew	2008	review	ovariectomy / ovariohysterectomy (and lap ass)	dorsal or Trendelenburg (15°–30°), 15°–25° to the side	2-port technique: caudal umbilical telescope port. Instrument port midway between telescope port and pubis	10–12
Gower and Mayhew	2008	review	ovariectomy / ovariohysterectomy (and lap ass)	dorsal or Trendelenburg (15°–30°), 15°–25° to the side	2-port technique: caudal umbilical telescope port. Instrument port midway between telescope port and pubis	10–12
Culp et al.	2009	clinical trial	ovariectomy	dorsal, 25° tilted to the side	2-port technique: telescope port 1 cm caudal to the umbilicus. Instrument port 2 to 5 cm cranial to the pubis	9–12
Dupré et al.	2009	clinical trial	ovariectomy	dorsal, 90° tilted to the side	1-port technique: 1 to 2 cm caudal to the umbilicus 2-port technique: telescope 2 cm caudal to the	8–12

					umbilicus. Instrument port cranial to the umbilicus and slightly paramedian	
Dutta et al.	2010	prospective study	ovariectomy / ovariohysterectomy	Trendelenburg	3-port technique: telescope port at the umbilicus. Instrument portals: distal to the laparoscope insertion site and 4 to 6 cm bilaterally from the ventral midline	10–12
Rivier et al.	2011	prospective clinical study	ovariectomy and laparoscopic-assisted gastropexy	Trendelenburg	3-port technique: telescope port at the umbilicus. Instrument portals: one on each side of the mammary glands (usually between the third and fourth)	8–10
Öhlund et al.	2011	prospective clinical study	ovariectomy	slight Trendelenburg, tilted to the side	3-port technique: telescope port 1 to 1,5 cm caudal to the umbilicus. Instrument portals 1 to 1,5 cm cranial to the umbilicus midway between umbilicus and pubic bone.	8–9
Case et al.	2011	randomized clinical trial	ovariectomy	dorsal, tilted to the side	1-port technique: 1 cm caudal to the umbilicus 2-port technique: 1 cm cranial and caudal to the umbilicus 3-port technique: 1 cm cranial and caudal to the umbilicus, another	13

					one 2 cm caudal to the first cannula.	
Runge et al.	2012	pilot study	ovariectomy	dorsal, 25–30° tilted to the side	1-port technique: multiport 1 to 2 cm caudal to the umbilicus	9–12
Manassero et al.	2012	case series	ovariectomy	Trendelenburg (10°), 20° tilted to the side	1-port technique: multiport 3 cm caudal to the umbilicus	10
Runge and Mayhew	2013	retrospective case series	ovariectomy and gastropexy	30°–45° to the side, reverse Trendelenburg for gastropexy	1-port technique: lateral to the rectus abdominis muscle, 2 to 5 cm caudal to the 13th right rib.	8–10
Runge et al.	2014	case series	ovariectomy	dorsal, 30°–45° tilted to the side	1-port technique: multiport at the umbilicus	8–12
Pope et al.	2014	case series	ovariectomy	dorsal, tilted to the side	3-port technique: median, telescope 1 cm cranial to the umbilicus. Instrument portals: 1 cm caudal to the umbilicus, midway between the cranial edge of the pubic bone and umbilicus	12
Kuhn and Kampmann	2015	review	ovariectomy/ ovariohysterectomy	Trendelenburg	1- or 3-port technique: single umbilical multiport 3-port technique (midline): telescope umbilical Instrument portals: first port cranial to the bladder and second halfway between the telescope and the first instrument port.	-
Stiles et al.	2016	case report	gastropexy and ovariectomy	dorsal	1-port technique: multiport cranially to the level of the 13th rib, lateral to the	8–10

					rectus abdominis muscle.	
Liehmann et al.	2018	prospective clinical trial	ovariectomy	Dorsal with 0°/22,5°/45° lateral tilt	1-port technique (multiport): 1 to 2 cm subumbilical	12 for insertion, then 8

One of the most common laparoscopic procedures is ovariectomy (OVE). Access to the abdominal cavity is created followed by ovary removal. In general, the surgery starts in dorsal recumbency for port placement, techniques using one to three ports are employed.

A Trendelenburg position was documented several times to implement OVE (Van Goethem et al. 2003, Van Nimwegen et al. 2005, Nickel et al. 2007, Van Nimwegen and Kirpensteijn 2007, Dutta et al. 2010, Öhlund et al. 2011, Rivier et al. 2011, Manassero et al. 2012, Kuhn and Kampmann 2015). A variety of Trendelenburg angles are described, whereas Van Nimwegen et al. (2005), Van Nimwegen and Kirpensteijn (2007), Manassero et al. (2012) documented a specific Trendelenburg angle of 10° (Van Nimwegen et al. 2005, Van Nimwegen and Kirpensteijn 2007, Manassero et al. 2012).

An often-applied approach with this recumbency is a midline three-port technique with a telescope portal 1 to 2 cm caudal to the umbilicus, the instrument portals 1 to 2 cm cranial to the umbilicus and inbetween the umbilicus and pubis (Van Goethem et al. 2003, Van Nimwegen et al. 2005, Van Nimwegen and Kirpensteijn 2007, Öhlund et al. 2011, Pope and Knowles 2014). A similar technique was used by Nickel et al. (2007), the telescope was positioned at the umbilicus and the instruments caudal to the xiphoid process and cranial to the urinary bladder. While Dutta et al. (2010) inserted the telescope port at the umbilicus and the instrument ports distal to the laparoscope port 4 to 6 cm lateral to the midline on each side. A single umbilical multiport or a midline three-port technique with the telescope port placed at the umbilicus and instrument caudal to it are also described (Kuhn and Kampmann 2015).

Rivier et al. (2011) performed the ovariectomy in combination with gastropexy and gained access through three ports. The telescope port was at the umbilicus and two lateral instrument portals, one on each side of the mammary glands, usually between the third and fourth gland were used (Rivier et al. 2011).

Dupré et al. (2009) described an approach in dorsal recumbency with a single port technique 1 to 2 cm caudal to the umbilicus using an operating laparoscope or a two-port technique with an additional instrument port cranial to the umbilicus and slightly paramedian to avoid coming up the falciform ligament. The patients were then tilted into right lateral recumbency for left ovariectomy, and in left lateral recumbency for right OVE (Dupré et al. 2009).

Other studies recommend a slight lateral tilting angle or an angle between 15° and 45° as quoted below. A lateral tilt of the operating table was described by several authors, but no detailed information was documented (Nickel et al. 2007, Öhlund et al. 2011, Pope and Knowles 2014, Milovancev and Townsend 2015). Gower and Mayhew (2008) recommended an angle between 15° and 25° and used a two-port approach. The telescope portal was placed subumbilical and the instrument portal between the telescope port and the pubis. This recumbency facilitates a better view on the particular ovary (Gower and Mayhew 2008). In other publications a similar angle of 25° or 30° was used (Culp et al. 2009, Runge et al. 2012). Case et al. (2011) described laterally tilted positions for a better view on the ovaries. While Culp et al. (2009) used a two-port technique with the telescope port 1 cm caudal to the umbilicus and the instrument port 2 to 5 cm cranial to the pubis, Runge et al. (2012) performed the ovariectomy through a single port 1 to 2 cm subumbilical. In a more recent study (Runge and Mayhew 2013) recommended a specific angle of 30° or 45°, but the single port was placed lateral to the rectus abdominis muscle 2 to 5 cm caudal to the 13th right rib, because of the gastropexy performed through the same port. Runge et al. (2014) did use the same rotation of the dog with an umbilical single multiport approach in a different study. Liehmann et al. (2018) also recommended a similar angle of 45° in her study of recumbencies for OVE with a single subumbilical port. (Stiles et al. 2016) also placed the dogs in a 45° laterally tilted recumbency but chose a different location for the single port, because of the gastropexy performed in one go. The port was cranially to the level of the 13th rib and lateral to the rectus abdominis muscle (Stiles et al. 2016).

3.3. Ovarian Remnant Removal

Table 4: Ovatian remnant removal

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Naiman et al.	2014	case series	ovariectomy (ovarian remnant resection)	dorsal, 25°–35° tilted to the side	3-port technique: telescope port 1 cm caudal to the umbilicus. Instrument ports 2 to 5 cm cranial to the pubis and 2 to 4 cm caudal to the xiphoid process	8–12

Phipps et al.	2015	case series	ovariectomy (ovarian remnant resection)	dorsal, tilted to the side	3-port technique: telescope just caudal to the umbilicus, in three patients, the remaining portals were made cranial and caudal to the central portal along midline. In one patient, the cranial portal was made craniolateral to the camera portal on the right side. The caudal portal was made on midline.	-
Van Nimwegen et al.	2018	case series	ovarian remnant removal	Trendelenburg position (10°–15°), 20–30° tilted to the side, in some cases increase of the angle	3-port technique: midline telescope port 1 to 2 cm caudal to the umbilicus. I instrument ports: 1 to 2 cm cranial to the umbilicus and midway between umbilicus and pubic bone	8

For ovarian remnant removal (ORR), the approach is basically the same, for the sake of clarity it is quoted as a separate bullet. ORR is performed in dorsal recumbency with a lateral tilt (Naiman et al. 2014, Phipps et al. 2016). Naiman et al. (2014) documented an angle of 25° to 35° lateral tilt for each side, the telescope port was placed 1 cm caudal to the umbilicus and the instrument ports were inserted 2 to 5 cm cranial to the pubis and 2 to 4 cm caudal to the xiphoid process. Phipps et al. (2016) also used a midline three-port technique with the telescope port just caudal to the umbilicus and the instrument ports were made cranial and caudal to the telescope port, but in one case the cranial instrument port was inserted more lateral to the right side to avoid entering a distended stomach.

In a case series a 10° to 15° Trendelenburg recumbency is described with a lateral tilt of 20° to 30°, sometimes the angles were increased to facilitate adequate exposure of the ovarian remnants. A midline three-port technique was used with the telescope 1 to 2 cm caudal to the umbilicus and the instrument ports 1 to 2 cm cranial to the umbilicus and midway between umbilicus and pubis (Van Nimwegen et al. 2018).

3.4. Ovariohysterectomy

Table 5: Ovariohysterectomy

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Austin et al.	2003	case series	ovariohysterectomy	Trendelenburg (30°)	3-port technique: telescope umbilical. Instrument portals paramedian to the midline and at the level of the inguinal fold	13
Hancock et al.	2005	prospective study	Ovariohysterectomy	Trendelenburg (20°)	3-port technique: telescope umbilical. Instrument portals: paramedian lateral to a mammary gland in the caudal abdominal wall	10
Gower and Mayhew	2008	review	ovariohysterectomy (and lap. ass.)	dorsal or 15°–30° Trendelenburg 15°–25° tilted position to the side for the ovaries	3-port technique: Telescope port subumbilical. Instrument portals: first port 3 to 5 cm cranial to the umbilicus and second port 3 to 5 cm cranial to the pubis	10–12
Dutta et al.	2010	prospective study	ovariohysterectomy	Trendelenburg	3-port technique: telescope port at the umbilicus. Instrument portals: distal to the laparoscope insertion site and 4 to 6 cm bilaterally from the ventral midline	10–12
Berenjian et al.	2010	experimental study	ovariohysterectomy	Trendelenburg, 30° tilted to the side for each ovar, Trendelenburg for hysterectomy	3-port technique: telescope umbilical. Instrument portals: 5 cm caudal and cranial to umbilicus.	12
Bakhtiari et al.	2012	prospective study	ovariohysterectomy	Trendelenburg, 45° tilted to the	3-port technique: telescope port at the umbilicus. Instrument	12

				side for the ovaries	portals: 3 cm cranial and the second 3 cm caudal to the umbilicus	
Kuhn and Kampmann	2015	review	ovariohysterectomy	Trendelenburg	1-port technique: umbilical multiport 3-port technique (midline): telescope umbilical. Instrument portals: first port cranial to the bladder and second halfway between the telescope and the first instrument port.	-
Sánchez-Margallo et al.	2015	case series	ovariohysterectomy	dorsal, 25°–30° tilted to the side each ovar	1-port technique: umbilical multiport	10
Fransson et al.	2015	prospective study	ovariohysterectomy, lift device technique compared with capnoperitoneum	10° Trendelenburg	3-port technique: Telescope 2 cm caudal to the umbilicus, Instrument portals: first port midway between xiphoid and umbilicus, second port 2 to 3 cm cranial to the pubis	12
Hartmann et al.	2018	case report	Nephrectomy and Ovariohysterectomy (combined)	left lateral	3-port technique: telescope at the middle third of the right flank. Instrument portals: first inserted cranial and dorsal to the telescope port one, second inserted following the rules of triangulation	12

Ovariohysterectomy (OHE) is a laparoscopic castration technique in which both the ovaries and the uterus are removed. This surgical technique is chosen, for example, when the uterus is pathologically changed and needs to be removed. For OHE, dorsal recumbency is described as well as a lateral tilt to facilitate a proper view of the ovaries (Monnet and Twedt 2003, Gower and Mayhew 2008, Sánchez-Margallo et al. 2015).

Sánchez-Margallo et al. (2015) performed a single port OHE through the umbilicus. Gower and Mayhew (2008) used the same technique as described above for OVH.

There are several studies with the dogs positioned in Trendelenburg position to facilitate a better view of the ovaries (Austin et al. 2003, Hancock et al. 2005, Berenjian et al. 2010, Fransson et al. 2015, Kuhn and Kampmann 2015). Additionally, a lateral tilt of 45° for the ovaries is described in combination with Trendelenburg recumbency (Bakhtiari et al. 2012). Berenjian et al. (2010) positioned the dogs in a 30° laterally tilted position to electro-coagulate the ovarian pedicles.

In terms of port placement, a midline three port technique is common with the telescope port at the umbilicus and the instrument portals cranial and caudal to it (Austin et al. 2003, Hancock et al. 2005, Berenjian et al. 2010, Dutta et al. 2010, Bakhtiari et al. 2012). Berenjian et al. (2010) placed midline ports 5 cm cranial and caudal to the umbilicus. Hancock et al. (2005) chose a different location for the instrument ports, they were positioned paramedian, lateral to a teat in the caudal abdomen. A similar approach was documented, with the instrument ports 4 to 6 cm lateral to the midline caudal to the telescope port (Dutta et al. 2010). Austin et al. (2003) inserted the instruments through paramedian ports at the area of the inguinal fold. Fransson et al. (2015) applied a three-port technique with the telescope port 2 cm caudal to the umbilicus, the instrument ports halfway between xiphoid and umbilicus and 2 to 3 cm cranial to the pubis. The approach of Kuhn and Kampmann (2015) was the same for OVE.

In one case report, OVH was combined with right nephrectomy in left lateral recumbency using a three-port technique. The telescope port was at the middle third of the right flank, the first instrument port was inserted cranial and dorsal to the telescope and the second port in a classic laparoscopic triangulation port positioning (Hartmann et al. 2018).

3.5. Laparoscopically Assisted Ovariohysterectomy

Table 6: Laparoscopically assisted ovariohysterectomy

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHG)
Devitt et al.	2005	clinical trial	ovariohysterectomy (laparoscopically assisted)	dorsal, 90° tilted to the side for each ovary	2-port technique: telescope at the umbilicus. Instrument port: 4 to 5 cm cranial to the pubis	10–13

Mayhew and Brown	2007	clinical trial	ovariohysterectomy (laparoscopically assisted)	dorsal, 15°–25° tilted to the side for each ovary	3-port technique: telescope port 1 cm caudal to the umbilicus. Instrument portals: 3 to 5 cm cranial to the umbilicus and the second 3 to 5 cm cranial to the pubis.	10–15
Gower and Mayhew	2008	review	Ovariohysterectomy (and laparoscopically assisted)	dorsal or 15°–30° Trendelenburg 15°–25° tilted position to the side for each ovary	3-port technique: Telescope port subumbilical. Instrument portals: first port 3 to 5 cm cranial to the umbilicus and second port 3 to 5 cm cranial to the pubis	10–12
Adamovich-Rippe et al.	2013	retrospective case series	ovariohysterectomy (laparoscopically assisted)	dorsal, 25°–35° tilted to the side for each ovar	3-port technique: telescope port 1 cm caudal to the umbilicus. Instrument portals: 2 to 5 cm cranial to the pubis and the second portal 2 to 4 cm caudal to the xiphoid process	8–12
Niranjana et al.	2013	prospective clinical study	ovariohysterectomy (laparoscopically assisted), port study	dorsal, 45° tilted to the side for each ovary	Two different methods: 3-port technique: midline telescope 5 cm cranial to the umbilicus. Instrument portals: 2 cm caudal to the umbilicus and the second port 2 to 3 cm in front of the pubis 3-port technique: two paramedian ports (1 cm lateral to the row of mammary glands behind the umbilicus) and one port on ventral midline 2 to 3 cm cranial to the pubis, triangle formation	10–12
Wallace et al.	2015	prospective case series	ovariohysterectomy (laparoscopically assisted)	dorsal, 90° tilted to the side for each ovary	1-port technique: midline multiport placed at a third of the distance between the umbilicus and the pubis.	8

Lopez et al.	2017	case report	ovariohysterectomy (laparoscopically assisted)	dorsal, 45° tilted to the side for each ovary	1-port technique: midline multiport	10–12

Laparoscopically assisted ovariohysterectomy (LAOHE) is a frequently performed procedure. It is almost the same as a complete laparoscopic OHE, with the difference that the abdominal wall is opened wider and the uterus is ligated and removed extracorporeally. Basically, a laparotomic spay is performed with the help of laparoscopic instruments. For LAOHE dogs are generally placed in dorsal recumbency for port placement, however Gower and Mayhew (2008) mentioned also a mild Trendelenburg position, although this is not mandatory. LAOHE can be performed in dorsal recumbency. Like in OVE a LAOHE is mostly conducted in a lateral or in a lateral tilted position for each ovary (Devitt et al. 2005, Mayhew and Brown 2007, Gower and Mayhew 2008, Adamovich-Rippe et al. 2013, Niranjana et al. 2013, Wallace et al. 2015, Lopez et al. 2017). Devitt et al. (2005) used two ports, a telescope port at the umbilicus and an instrument port 4 to 5 cm cranial to the pubis. Adamovich-Rippe et al. (2013) and Mayhew and Brown (2007) placed the telescope port 1 cm caudal to the umbilicus and two more instrument portals a few centimetres cranial to the pubis and a few centimetres caudal to the xiphoid process.

Wallace et al. (2015) performed a single port technique in the midline a third of the distance between the umbilicus and the pubis. Another single multiport technique was used by Lopez et al. (2017). Also, a two-port technique with the telescope port 3 to 5 cm cranial to the umbilicus and the instrument port 3 to 5 cm cranial to the pubis on the ventral midline is described (Gower and Mayhew 2008). (Niranjana et al. 2013) documented two different three port techniques in their study, in one group of their study a midline telescope port 5 cm cranial to the umbilicus was used and the instrument ports were made 2 cm caudal to the umbilicus and 2 to 3 cm cranial to the pubis. In another group two paramedian ports 1 cm lateral to the mammary glands and behind the umbilicus were made, the left port first was used for the telescope and the right port for instruments and another instrument port was inserted midline 2 to 3 cm cranial to the pubis (Niranjana et al. 2013).

In another publication (Niraniana et al. 2014) positioned the dogs in dorsal recumbency for cannula insertion but tilted them in a 45° lateral angle to grasp the ovaries, here a three-port technique was used.

3.6. Gastropexy

Table 7: Gastropexy

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Mathon et al.	2009	experimental study	gastropexy	dorsal	3-port technique: telescope port at the umbilicus; instrument ports 6 to 7 cm left and right to it	9
Runge and Mayhew	2013	retrospective case series	ovariectomy and gastropexy	30°–45° to the side, reverse Trendelenburg for gastropexy	1-port technique: lateral to the rectus abdominis muscle, 2 to 5 cm caudal to the 13th right rib.	8–10
Spah et al.	2013	clinical trial	gastropexy	dorsal	3-port technique: midline telescope port between the instrument ports; midline instrument ports: 2 to 3 cm caudal to the umbilicus and the second one 2 to 3 cm caudal to the xiphoid process	8
Allen et al.	2014	review	gastropexy	-	3-port technique: midline telescope between the two instrument ports: 1 cm caudal to the umbilicus, and 3 to 4 cm caudal to the xyphoid	-
Stiles et al.	2016	case report	gastropexy and ovariectomy	dorsal	1-port technique: multiport cranially to the level of the 13th rib, lateral to the rectus abdominis muscle.	8–10
Fox-Alvarez et al	2016	experimental study	gastropexy	dorsal, slightly left oblique	2-port technique: telescope midline 1 cm caudal to the umbilicus; instrument port midway between the xiphoid and umbilicus.	8–10
Takacs et al.	2017	retrospective case series	gastropexy	dorsal-left oblique	2- or 3-port technique: ventral midline placements (only pictures)	-

In a gastropexy, the stomach is sutured to the abdominal wall. This can be necessary in the course of an operation for a gastric volvulus, but also as a prophylactic measure against it. Laparoscopic gastropexy is generally performed in dorsal recumbency (Mathon et al. 2009,

Spah et al. 2013, Stiles et al. 2016). However, there is also the option of dorsal recumbency with a slight tilt to the left (Fox-Alvarez et al. 2016, Takacs et al. 2017). Another way to get access to the stomach is by placing the patients in reverse Trendelenburg position. This recumbency enables an even better view and more room to conduct the gastropexy (Runge and Mayhew 2013).

There are several port techniques described with different locations of the ports. An entry with two ports is documented in an experimental study, the telescope port was placed 1 cm caudal to the umbilicus and another port was placed midline between the xiphoid and the umbilicus (Fox-Alvarez et al. 2016).

Several surgeons utilized three ports to get access to the stomach (Mathon et al. 2009, Spah et al. 2013, Allen and Paul 2014). Mathon et al. (2009) placed the telescope port through the umbilicus and the one instrument port on each side 6 to 7 cm lateral to the telescope port. Whereas also a midline approach with the first instrument port placed about 3 cm caudal to the xiphoid process, the second port a few centimetres caudal to the umbilicus and the instrument port between these ports was reported (Spah et al. 2013, Allen and Paul 2014).

Takacs et al. (2017) tried variations of two to three multi- and single-port placements on the ventral midline.

Stiles et al. (2016) and Runge and Mayhew (2013) used a single multi-port approach. For combined gastropexy and ovariectomy, the port was placed paramedian on the right side and cranial or caudal to the level of the 13th rib directly lateral to the rectus abdominis muscle.

3.7. Laparoscopically Assisted Gastropexy

Table 8: Laparoscopically assisted gastropexy

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Rawlings et al.	2001	experimental prospective clinical trial	gastropexy (lap ass)	dorsal	2-port technique: telescope port midline 2 to 3 cm caudal to the umbilicus; instrument port lateral to the right margin of the rectus abdominus and 3 cm caudal to the 13th rib.	-

Rawlings	2002	review	gastropexy (lap ass)	dorsal	2-port technique: telescope port midline 2 to 3 cm caudal to the umbilicus; instrument port lateral to the right margin of the rectus abdominus and 3 cm caudal to the 13th rib.	-
Monnet and Twedt	2003	review	gastropexy (lap ass), other procedures	dorsal	2-port technique: telescope port midline at the umbilicus instrument portal 2 cm behind the 13th rib on the right side	10
Balsa et al.	2017	prospective clinical trial	gastropexy (lap ass)	dorsal	2-port technique: telescope port midline 2 cm caudal to the umbilicus; instrument port lateral to the right rectus abdominis muscle about 3 cm caudal to the 13th rib.	9–12
Rivier et al.	2011	prospective clinical study	laparoscopically assisted gastropexy, (ovariectomy)	reverse Trendelenburg for gastropexy	3-port technique: telescope port at the umbilicus; instrument portals, one on each side between the third and fourth mammary glands	8–10

This operation is carried out for the same reasons as described in the previous chapter. The technique differs in that the procedures not only performed via the ports in the abdominal cavity and the stomach is sewn on from the inside, but from the outside. A laparoscopic assisted gastropexy is also performed in dorsal recumbency (Rawlings et al. 2001, 2002a, Monnet and Twedt 2003, Balsa et al. 2017). The same two-port technique was used in all cases with the telescope port midline at the umbilicus or 2 to 3 cm caudal to it and the instrument port lateral to the right margin of the rectus abdominis and 3 cm caudal to the last rib (Rawlings et al. 2001, 2002a, Balsa et al. 2017). In one review the instrument port location was described 2 cm behind the last rib on the right side and at the junction of distal and proximal third of the last rib (Monnet and Twedt 2003).

There is another clinical study using reverse Trendelenburg positioning for laparoscopic assisted gastropexies in combination with ovariectomy (Rivier et al. 2011). Due to the

combination of the procedures the ports were placed differently. Three ports where used: a telescope port at the umbilicus and one lateral instrument portal on each side of the mammary glands, usually between the third and fourth gland (Rivier et al. 2011).

3.8. Pyloroplasty (Pursuant Finney)

Table 9: Pyleroplasty

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Sánchez-Margallo et al.	2007	experimental study	pyloroplasty	dorsal	3-port technique: telescope caudal to the umbilicus, instrument ports slightly cranial and lateral to it. (only pictures)	12–14

Pyloroplasty can be performed, for example, in case of duodenal ulcer or pyloric stenosis. Damaged or misshapen tissue of the small intestine and stomach is removed and the organs are reconstructed. For the experimental procedure in the study of SANCHEZ-MARGALLO et al. (2007) dorsal recumbency and a three-port technique was used. As can be seen in a figure in the paper, the telescope was placed caudal to the umbilicus and two instrument ports slightly cranial and lateral to it.

3.9. Splenectomy

Table 10: Splenectomy

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Al-Hasan and Al-Heani	2009	clinical study	splenectomy (partial)	dorsal	3-port technique: telescope at the side of the umbilicus, two instrument ports near the umbilicus	12
Stedile et al.	2009	clinical prospective study	splenectomy	dorsal, (45° tilted to the right, when needed)	3-port technique: telescope in the right abdominal wall, near the umbilicus. Instrument portals: midline between the umbilicus and xiphoid process, midway between the pubis and the umbilicus	12
Collard et al.	2010	clinical report	splenectomy	dorsal	3-port technique: midline umbilical telescope port;	10–12

					instrument portals: midline, 1 cm cranial to the prepuce and the second 5°cm lateral and caudal to the first instrument portal.	
Bakhtiari et al.	2011	clinical trial	splenectomy	dorsal, 45° tilted to the right	3-port technique: telescope port at the umbilicus; first instrument port 3 cm above the umbilicus, second port 3 cm cranial to the umbilicus	12
Khalaj et al.	2012	clinical study	splenectomy, port study	trendelenburg, 30° tilted to the right	1-port technique: multiport caudal to the umbilicus 3 port technique: umbilical telescope port (but variations) other ports 3 cm cranial and cauda to it	12
Shaver et al.	2014	case series	splenectomy	dorsal or right lateral recumbency (only one patient)	3-port technique (dorsal recumbency): telescope port 2 cm caudal to the umbilicus Instrument portals: two ports in the left caudal abdominal wall other 3-port technique (dorsal recumbency): telescope port umbilical or subumbilical instrument ports: one port in die caudal abdomen on each side (a forth port was required in one dog), or 2 midline ports, cranial and caudal to the umbilicus, or a caudal midline port and left caudal abdominal port. 3-port technique (lateral recumbency): telescope port 3 to5 cm lateral to the umbilicus. Instrument portals: one port in the left cranial and one in left caudal abdominal wall.	8–12
Shaver et al.	2015	case series	splenectomy	dorsal or right lateral recumbency (only one patient)	same ports as described above (Shaver et al. 2014)	8–12
TaeYeong et al.	2016	case series	splenectomy	right lateral	3-port technique: (female dog) telescope port umbilical;	10–12

					instrument ports 2 cm caudal to the umbilicus and 7 cm caudal to the umbilicus (portal 3 inserted after right recumbency) male dog: telescope port 2 cm cranial to the umbilicus instrument ports: 1 cm cranial to the prepuce and second 5 cm caudal and right from the first port	

During splenectomy, the spleen is removed. After gaining access to the abdominal cavity, the spleen is removed and, for example, retrieved from the abdomen using a retrieval bag. There are three studies with dogs placed in dorsal recumbency (Stedile et al. 2009, Collard et al. 2010, Shaver et al. 2015). Shaver et al. (2015) placed the telescope in an umbilical or subumbilical port and the instrument ports in the right and left caudal abdomen, or midline, cranial and caudal to the umbilicus. Collard et al. (2010) placed the telescope port also through the umbilicus and the instrument ports 1 cm cranial to the prepuce and the second 5 cm lateral and caudal to the first instrument portal. To enable a better view of the dorsal extremity of the spleen and its vessels, a 45° right lateral position is suggested (Stedile et al. 2009, Bakhtiari et al. 2011). In both articles a three-port technique was applied, but the ports were located differently. Bakhtiari et al. (2011) inserted the telescope at the umbilicus, the instrument ports 3 cm cranial to the umbilicus and in the left caudolateral abdomen 3 cm cranial to the umbilicus Stedile et al. (2009) positioned the telescope port in the right abdominal wall near the umbilicus, the first instrument portal was placed midway between the xiphoid and the umbilicus, the second between the pubis and the umbilicus. This provided good visualization and manipulation of the splenic hilus. Another recumbency for this procedure is a right lateral position (Shaver et al. 2015, TaeYeong et al. 2016). TaeYeong et al. (2016) set the telescope port at the umbilicus in a female or 2 cm cranial to the umbilicus in a male dog. The instrument ports were placed 2 cm caudal to the umbilicus and 7 cm caudal to the umbilicus in the female or 1 cm cranial to the prepuce and 5 cm caudal and right from the first port instrument port in the male dog (TaeYeong et al. 2016). Another opportunity is placing the camera port 3 to 5 cm lateral to the umbilicus on the right side and the instrument ports in the left cranial and left caudal abdomen (Shaver et al. 2015). On the one hand, rotation of the patients to the left helps to improve the view on the surrounding and the splenic vessels. On the other hand, rotating the patient to the right can enhance the sight of the dorsal extremity (Shaver et al. 2015).

But there is also data where the patients were placed in Trendelenburg recumbency tilted 30° to the right. In this publication the difference between a single multi-port placed caudal to the umbilicus and a technique with three ports was evaluated. For the three-port technique, the telescope port was placed midline at the umbilicus and the instrument ports 3 cm cranial and caudal to it (Khalaj et al. 2012).
Partial splenectomy was performed by Al-Hasan and Al-Heam (2009) in dorsal recumbency, with the telescope at the side of the umbilicus and two instrument ports near the umbilicus.

3.10. Laparoscopically assisted Splenectomy

Table 11: Laparoscopically assisted splenectomy

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Wright et al.	2016	retrospective case series	splenectomy (laparoscopically assisted), port study, abdominal exploration	dorsal/sometimes 45° lateral to visualize gutters	1-port technique: caudal to the umbilicus 2-port technique: telescope1 cm caudal to the umbilicus; instrument portal 5 cm cranial and 3 cm lateral to the telescope portal or 5 cm cranial on the midline	8–10

The procedure for this operation is the same as in the previous chapter, except that after examination of the spleen, the access to the abdominal cavity is enlarged and the spleen is removed externally. For laparoscopic-assisted splenectomy, dorsal recumbency is described with either a single port caudal to the umbilicus or with an additional instrument port placed 5 cm cranial and 3 cm lateral to the telescope, or 5 cm cranial to it. Also tilted positions to the side improve the view for exploration in some cases (Wright et al. 2016).

3.11. Adrenalectomy

Table 12: Adrenalectomy

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal

						pressure (mmHg)
Jiménez-Peláez et al.	2008	case report	adrenalectomy	lateral (with cushion)	4-port technique: located in the paralumbar fossa caudal to the 13th rib. Three portals were made along a virtual half-circle with the telescope in the middle. A fourth instrumental portal above the kidney.	8–10
Naan et al.	2013	experimental, prospective clinical study	adrenalectomy	sternal	3-port technique: telescope port in paralumbar fossa 2 to 3 cm caudal to the the 13th rib,ipsilateral to the affected side. Instrument portals: caudodorsal of the telescope port (placed in a virtual half circle)	6
Mayhew et al.	2014	case series	adrenalectomy	dorsal recumbency and then rolled into lateral recumbency (earlier cases) or were initially positioned in lateral recumbency (later cases) with the affected side up	3- or 4-port technique: telescope port subumbilical (first 3 dogs), later 3 to 5 cm lateral to the umbilicus at the affected side. Instrument ports: first cranial instrument port 5 to 10 cm cranial and 5 to 8 cm lateral to the telescope port ipsilateral to the lesion. Second caudal instrument port 5 to 10 cm caudal and 5 to 8 cm lateral to the telescope port. third port over the location of the kidney (if needed).	8–12
Pitt et al.	2016	case series	adrenalectomy	lateral recumbency with the affected side up, in most cases, the surgical table was tilted 20°–30° laterally to elevate the dog's spine and create a	3- or 4-port technique: telescope port umbilical first, then 2 to 3 cm lateral to the umbilicus Instrument ports: first portal just caudal to the costal arch on the affected side and the second in the caudal quadrant 5 to 8 cm lateral to the ventral midline and slightly more proximal than the telescope port. Third port at the level of the kidney (if needed).	8–12

				semisternal recumbency		
Jeong et al.	2016	experimental study	retroperitoneal access	sternal	Transperitoneal cranial to the iliac crest for exploration. Retroperitoneal trocar at the level of the 2nd lumbar vertebrae on the right side and 3rd lumbar vertebrae on the left side.	5–10

In veterinary medicine laparoscopic adrenalectomy is getting more and more common. This surgery removes one or both of the adrenal glands. Often this is necessary due to tumorous degeneration.

There are two ways to perform the procedure: either the dog is placed in lateral recumbency or in sternal recumbency.

If the dog is positioned in lateral recumbency it is placed on the unaffected side, with a cushion under the spine to raise it. The advantage of putting a cushion under the spine is displacement of abdominal organs by gravity (Jiménez Peláez et al. 2008). Often the stomach or spleen interfere with the view of the cranial pole of the left adrenal gland, and the caudal margin of the gland can be covered by the left kidney. Also, Mayhew et al. (2014) found out that it is the best option to place the dogs in lateral recumbency with the option to tilt the patients into a more sternal position. There is also a published case series in which the authors used a semilateral position of 20° to 30° (Pitt et al. 2016). In both papers a similar three- or four-port approach was used. Mayhew et al. (2014) placed the camera port 3 to 5 cm lateral to the umbilicus and the instrument ports were placed 5 to 8 cm lateral and 5 to 10 cm cranial and caudal to the telescope. Pitt et al. (2016) also used the same number of ports and entered the instruments quite similar, but the telescope port was placed umbilical at first and then 2 to 3 cm lateral to it. If a fourth port was used for tissue retraction, it was placed in the location of the kidney (Mayhew et al. 2014, Pitt et al. 2016).

The other option is the sternal position with cushions placed under the thorax and pubis to allow a gravitational displacement of the abdominal organs by suspending the abdomen. This generates an improved working space for the adrenalectomy and an adequate view on the glands (Naan et al. 2013, Jeong et al. 2016). However, Naan et al. (2013) reported that the right adrenal gland is harder to remove.

In terms of port placement, it is recommended to use a number of three or four ports. A common approach is to place the three ports in a virtual circle in the paralumbar fossa with

the adrenal gland as a centre point, starting with the first instrument port just caudal to the costal arch and followed by the telescope port and another instrument port (Jiménez Peláez et al. 2008, Naan et al. 2013, Milovancev and Townsend 2015). This allows a working triangulation principle. If a fourth port was needed for a retraction or suction device, it was positioned above the kidney (Jiménez Peláez et al. 2008, Milovancev and Townsend 2015).
In an experimental study the retroperitoneal space was successfully approached by placing the telescope port at the cranial margin of the iliac crest and the instrument at the level of the transverse process of the second lumbar vertebrae on the right side and on the third lumbar vertebrae and the left side (Jeong et al. 2016).

3.12. Nephrectomy

Table 13: Nephrectomy

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Kim et al.	2013	experimental study	nephrectomy	15° Trendelenburg (for port placement), dorsal 60–80° tilt to the right (left kidney)	3-port technique: telescope port 3 to 5 cm caudal to the umbilicus and 2 to 3 cm to the left. Instrument portals: first 3 to 5 cm caudal to umbilicus and 1,5 to 3 cm to the right. Second port 2 to 4 cm cranial to the umbilicus and 1,5 to 3 cm to the right.	10–12
Mayhew et al.	2013	experimental study/case series	nephrectomy / ureteronephrectomy	(near) lateral position with sandbag under epaxial muscles	3/4-port technique: telescope portal 1 cm caudal to the umbilicus. Instrument portals: first just caudal to the last rib in the cranial abdominal quadrant on the affected side and the second in the caudal abdominal quadrant just cranial to the pelvic limb. (in one dog different ports)	8–12
Shariati et al.	2014	experimental study	nephrectomy	right lateral	4-port technique: telescope port left lateral	-

					to the umbilicus. 3 Instrument ports proximal and left lateral side to the telescope port. (only picture)	
Hartmann et al.	2018	case report	nephrectomy and ovariohysterectomy (combined)	left lateral	3-port technique: telescope at the middle third of the right flank. Instrument ports: first cranial and dorsally to the telescope port, second inserted in a classic laparoscopic triangulation port positioning.	12

This surgery will remove one or both kidneys. There are many reasons why these need to be removed, for example, trauma or neoplasia. For nephrectomy there were several recumbencies tested in experimental studies. A 15° Trendelenburg was used to provide cranial displacement of the abdominal viscera for port placement (Kim et al. 2013). To get access to the left kidney, dorsal recumbency with a 60° to 80° tilt to the side or right lateral recumbency is described (Kim et al. 2013, Shariati et al. 2014). (Kim et al. 2013) inserted the telescope port 3 to 5 cm caudal and 2 to 3 cm left laterally to the umbilicus. The first instrument was placed 3 to 5 cm caudal to the umbilicus and 1,5 to 3 cm right laterally from that point. The second instrument port was made 2 to 4 cm cranial and 1.5 to 3 cm right laterally to the umbilicus (Kim et al. 2013). Shariati et al. (2014) used different positions for the ports, the telescope port was set left lateral to the umbilicus and three more instrument ports left lateral side to the telescope port. For the right kidney the opposite left lateral recumbency is recorded with the telescope port the middle third of the right flank and the first instrument ports cranial and dorsally to it, the second instrument port was placed following rule of triangulation (Hartmann et al. 2018). In another experimental study, patients were positioned in near lateral recumbency with a small foam wedge under the epaxial musculature (Mayhew et al. 2013). A three-port technique was used generally, the telescope port was positioned 1 cm caudal to the umbilicus, the instrument ports just caudal to the last rib on the affected side (first) and just cranial to the pelvic limb (Mayhew et al. 2013).

3.13. Cholecystectomy

Table 14: Cholecystectomy

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Mayhew et al.	2008	case series	cholecystectomy	-	4-port technique: camera portal 1 cm caudal to the umbilicus. Instrument portals: first port 5 to 8 cm lateral and 3 to 5 cm cranial to the umbilicus on the left side, second 3 to 5 cm lateral and third port 5 to 8 cm lateral to the umbilicus on the right side (triangulated around the gall bladder)	10–15
Lee et al.	2011	experimental study	cholecystectomy	-	1-port technique (multiport): periumbilical	<5
Milovancev and Townsend	2015	review	biopsy of spleen/ kidney/GIT, splenectomy, nephrectomy, ovariectomy, ovariohysterectomy, cryptorchidectomy, adrenalectomy, cisterna chyli ablation, cholecystectomy, portosystemic shut	dorsal, adopted Trendelenburg	4-port technique: telescope port in the right cranial quadrant close to the midline. Instrument ports: subumbilical port, a left cranial quadrant port, and a right cranial quadrant port, triangulated around the gall bladder.	-

During this operation, the gallbladder is removed. It is dissected out of the liver and separated. Cholecystectomy is performed in dorsal recumbency (Milovancev and Townsend 2015).

For this procedure a technique with four ports is reported. The telescope is placed caudal to the umbilicus, one instrument ports is positioned in the left cranial quadrant and another two ports are placed in the right cranial quadrant of the abdomen (Milovancev and Townsend 2015). Mayhew et al. (2008) described the placements even more precisely with the camera portal 1 cm caudal of the umbilicus, the left instrument port 5 to 8 cm lateral and 3 to 5 cm cranial and the two portals on the right 3 to 5 cm and 5 to 8 cm lateral to the telescope port. The aim of both techniques was to triangulate around the position of the gall bladder. In one experimental study a single multiport was inserted periumbilical, to conduct the procedure (Lee et al. 2011).

3.14. Cholecystostomy

Table 15: Cholecystostomy

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Murphy et al.	2007	experimental/clinical report	cholecystostomy, (pigtail cholecystostomy catheter)	dorsal, left lateral (different studies)	2-port technique: telescope port 1 cm cranial to the umbilicus. Instrument port 4 cm caudal and lateral to the right side of the xyphoid process	10

In this experimental technique, a catheter is inserted into the gallbladder. The research revealed only one experimental cadaver study. For this procedure, the dogs were placed in dorsal recumbency (Murphy et al. 2007). An approach with one telescope portal 1 cm cranial to the umbilicus and one instrument port placed 4 cm caudal and lateral to the right side of the xyphoid process was used (Murphy et al. 2007).

3.15. Cholecystocentesis

Table 16: Cholecystocentesis

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)

Shamir et al.	2019	retrospective study	abdominal exploration, biopsies, cholecystocentesis	dorsal, 45° to the side	1-port technique: midline 1 cm caudal to the umbilicus 2-port technique (for biopsies): same telescope port, instrument port cranial or caudal to it or 2 to 4 cm lateral to the telescope port	8–12

In this experimental technique, a catheter is inserted into the gallbladder. A percutaneous centesis is described by (Shamir et al. 2019) in dorsal recumbency with the same ports described for liver biopsies below.

3.16. Cholecystoduodenostomy

Table 17: Cholecystoduodenostomy

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Martín-Portugués et al.	2016	experimental study	Cholecysto-duodenostomy	reverse Trendelenburg (15°)	4-port technique: telescope port at the umbilicus or 1 cm cranial to it. Instrument ports: located in varying positions depending on the case. Version 1: first and second port lateral to the rectus sheath and second port medial to it at the level of the first port. Version 2: ports were positioned more cranial and apart from one another. Version 3: combination of Version 2 and 3. In all cases, the third	10

					port was placed just caudal to the osteochondral junction of last 13th left rib.	

In this experimental technique, a stoma is created between the gallbladder and the duodenum. The gall bladder and the duodenum are opened and sutured together. For this procedure a 15° Trendelenburg recumbency is mentioned in the literature (Martín-Portugués et al. 2016). In this experimental cadaver study, a four-port technique was used with the telescope port at the umbilicus or 1 cm cranial to it, the instrument ports were located in varying positions depending on the case. The authors recommended to do further studies to evaluate an applicable approach and technique for this procedure (Martín-Portugués et al. 2016).

3.17. Portosystemic Shunt Attenuation

Table 18: Portosystemic shunt attenuation

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Miller and Fowler	2006	case reports	portosystemic shunt attenuation	dorsal	4-port technique: telescope port 1 cm caudal to the umbilicus instrument portals: first and second in the left and right paramedian abdominal wall between the ribs and the umbilicus and the third instrument port between in the right caudal abdomen between the umbilicus and pubis	12

In this operation, vascular abnormalities, i.e. connecting blood vessels between the portal vein and the caudal vena cava, are ligated. The literature search revealed one publication of two cases with the dog in dorsal recumbency (Miller and Fowler 2006). A four-port technique was used, the telescope port was placed midline 1 cm caudal to the umbilicus, the instrument ports in the left and right paramedian abdominal wall between the ribcage and the umbilicus and the third instrument port between in the right caudal abdomen between the umbilicus and pubis (Miller and Fowler 2006).

3.18. Cryptorchidectomy

Table 19: Cryptorchidectomy

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Monnet and Twedt	2003	review	cryptochidectomy and other procedures	Trendelenburg	-	10
Spinella et al.	2003	case series	cryptorchidectomy	dorsal	3-port technique: telescope port 4 cm cranially to the umbilicus. Instrument portals in the right and left in inguinal regions in the parapreputial region.	12
Runge et al.	2014	retrospective case series	cryptorchidectomy	dorsal/Trendelenburg and 20°–45° tilted lateral to expose testis	1-port technique: multiport at the umbilicus	8–10

Cryptorchidectomy is the removal of the abnormally located testicle in a cryptorchid dog. This testicle can come to lie in the abdomen or in the inguinal canal and therefore must be removed due to the high risk of tumorous degeneration. For cryptorchidectomy, dogs were placed in dorsal recumbency. A three-port technique was employed with the telescope portal 4 cm cranial to the umbilicus and the two instrument ports right and left in inguinal regions to facilitate triangulation (Spinella et al. 2003). A Trendelenburg position is described for better visualization of the inguinal canal (Monnet and Twedt 2003).

(Runge et al. 2014b) used different recumbencies, dogs were placed in dorsal recumbency, but also in Trendelenburg position. In some cases, the patients were placed in lateral or laterally tilted recumbency of 20° to 45°, this exposed the affected testicle. The single multi-port was inserted at umbilicus for cryptorchidectomy and for patients that had a combination of cystotomy. If a laparoscopic-assisted gastropexy was combined with cryptorchidectomy, the port was placed just lateral to the rectus abdominis muscle and about 2 to 3 cm caudal to the right last rib (Runge et al. 2014b).

3.19. Laparoscopically Assisted Cryptorchidectomy

Table 20: Laparoscopically assisted cryptorchidectomy

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Miller et al.	2004	case series	cryptorchidectomy (laparoscopically assisted)	Trendelenburg (20°) and slightly tilted laterally to the opposite side	2-port technique: telescope port just caudal to the umbilicus Instrument portals: ventral and slightly lateral to the observed testicle	10–12
Urbanová et al.	2009	case series	cryptorchidectomy (laparaoscopically assisted)	dorsal	3-port technique: telescope port midline slightly cranial to the umbilicus Instrument portals: both in the inguinal region parapreputially according to the principles of triangulation	10–12

Here, too, the cryptorchid testicle is identified with the help of laparoscopic instruments but is then removed in the classic way without a laparoscopic technique. For this procedure dorsal recumbency and a 20° Trendelenburg position with a lateral tilt away from the affected side is described (Miller et al. 2004, Urbanová et al. 2010). Urbanová et al. (2010) used a technique with the telescope port slightly cranial to the umbilicus and two instrument ports in the parapreputial inguinal region.

In another case series dogs were placed in Trendelenburg position and a technique with only two portals was applied. The laparoscope port was placed just caudal to the umbilicus and the instrument port was inserted in a position ventral and slightly lateral to the identified testicle (Miller et al. 2004).

3.20. Vas Deferentopexy

Table 21: Vas deferentopexy

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Salomon et al.	2002	case report	vas deferentopexy	Trendelenburg	3-port technique:	<9

					telescope caudal to the umbilicus. Instrument portals: placed on the right and left abdominal flank, 5 cm lateral to the third mammary gland.	

A vas deferentopexy can be performed on incontinent males, in which the deferent duct is cut off and sewn to the abdominal wall and used as a kind of pulling device. This allows strengthening additional to the sphincter muscle. In a case report of Salomon et al. (2002), a Trendelenburg position is described, allowing the organs to slide cranially. A three-port technique was applied with the telescope caudal to the umbilicus and the instruments placed on each abdominal flank, 5 cm laterally to the third mammary gland (Salomon et al. 2002).

3.21. Laparoscopically Assisted Colopexy

Table 22: Laparoscopically assisted colopexy

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Mathon et al.	2011	experimental study	colopexy, sterilization (laparoscopically assisted)	dorsal	3-port technique: telescope port at the umbilicus instrument portals: 7 to 8 cm to the right and left of the telescope port	<9
Zhang et al.	2012	clinical trial	colopexy (laparoscopically assisted)	dorsal	2-port technique: telescope midline, 1 to 2 cm caudal to the umbilicus. instrument port 2,5 cm to the right of ventral midline	-

In this technique, the colon is identified using laparoscopic instruments and sewn to the abdominal wall. Mathon et al. (2011) conducted an experimental study with the dogs in dorsal recumbency for colopexy. The telescope port was inserted through the umbilicus and both instrument portals 7 to 8 cm to the left and right of the telescope (Mathon et al. 2011).
In another publication dogs were placed in dorsal recumbency, a two-port technique was applied with the telescope in the midline 1 to 2 cm caudal to the umbilicus and the instrument port 2,5 cm to the right of ventral midline (Zhang et al. 2012).

3.22. Cystopexy

Table 23: Cystopexy

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Alvarez et al.	2015	cadaver study	cystopexy	Trendelenburg (15°) with a left lateral tilt	3-port technique: telescope 2 cm cranial to the umbilicus Instrument portals: first 2 cm caudal to the umbilicus, second at the level of the umbilicus to the side and twice the lateral distance from the umbilicus to the mammary glands	<8

In a cystopexy, the urinary bladder is sutured to the abdominal wall. The literature search revealed only one paper where laparoscopic cystopexy was performed. In this cadaver study the dogs were positioned in a 15° Trendelenburg position with a left lateral tilt. In this experimental study a technique with three ports was attempted: the telescope 2 cm cranial to the umbilicus and the first instrument port 2 cm caudal to the umbilicus and second twice the lateral distance from the umbilicus to the abdominal mammary gland to the right and at the level of the umbilicus (Alvarez et al. 2015).

3.23. Laparoscopically Assisted Cystic Procedures

Table 24: Laparoscopically assisted cystic procedures

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Rawlings et al.	2002	case series	cystopexy (laparoscopically assisted)	slight Trendelenburg	2-port technique: telescope port 2 to 3 cm caudal to the umbilicus. Instrument port lateral to the right rectus abdominis muscle in the mid-abdominal area (male dogs). Or was placed lateral to the first trocar and just lateral to the	-

					rectus abdominis muscle (female dogs)	
Rawlings et al.	2003	case series	cystic calculi removal (laparoscopically assisted)	Trendelenburg	2-port technique: telescope port 2 to 3 cm caudal to the umbilicus Instrument port midline for female and paramedian for males. Then telescope directly into the bladder.	-
Rawlings et al.	2007	case report	cystoscopy/polyps removal (laparoscopically assisted)	Trendelenburg (5°)	2-port technique: telescope port 2 to 3 cm caudal to the umbilicus, Instrument port midline, directly ventral to the cranial margins of a moderately distended bladder	<15
Zhang et al.	2010	prospective cohort study	Cystostomy (laparoscopically assisted)	Trendelenburg (30°)	3-port technique: telescope midline and midway between the xiphoid and umbilicus. Instrument portals: 8 to10 cm caudal to the telescope and 8 to 12 cm to the side on both sides	10
Runge et al.	2011	retrospective case series	cystic and urethral calculi retrieval (laparoscopically assisted)	dorsal	midline incision over bladder, telescope directly into the bladder	-
Pinel et al.	2013	clinical report	cystotomy for urolith removal (laparoscopically assisted)	Trendelenburg	2-port technique: telescope at the umbilicus. Second portal cranial to the prepuce in male dogs and about 2/3 of the way between the pubis and the umbilicus in female dogs. Then telescope directly into the bladder.	-

All of these procedures involve entering, or examining the bladder using laparoscopic instruments. However, the actual operation is performed via laparotomy. The cystic and urethral calculi removals (Takacs et al. 2017) were performed in dorsal recumbency with the telescope directed into the urinary bladder after it was sutured to the abdominal wall (Runge et al. 2011).

In several publications the authors place the dog in a Trendelenburg position for cystoscopy as well as for cystopexy (Rawlings et al. 2002b, 2003, Rawlings 2007).
For cystic calculi or polyp removals a two-port technique was used with the telescope port 2 to 3 cm caudal to the umbilicus and the instrument port midline for female and paramedian for males over the cranial margin of the bladder (Rawlings et al. 2003, Rawlings 2007). For cystopexy also, two ports were used: the camera port in the same location, but the instrument port was positioned lateral to the right rectus abdominis muscle in the mid- abdominal area in male dogs and lateral to the first trocar and just lateral to the rectus abdominus in female dogs (Rawlings et al. 2002b).
Pinel et al. (2013) established the telescope portal at the umbilicus and the instrument port cranial to the prepuce in male dogs and about two thirds of the way between the pubis in female dogs.
(Zhang et al. 2010) also used a 30° Trendelenburg position for cystostomy to allow for a cranial displacement of the abdominal organs.

3.24. Laparoscopically Assisted Feeding Tube Placement

Table 25: Laparoscopically assisted feeding tube placement

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Rawlings et al.	2002	experimental study	enterostomy tube placement, jejunum biopsy with serosal patch (laparoscopically assisted)	dorsal	2 to 3-port technique: midline telescope port 2 to 3 cm caudal to the umbilicus Instrument ports: first port lateral to the right rectus abdominis muscle in the midabdominal area. Second port for jejunal biopsy at the same location on the left side.	-
Hewitt et al.	2004	prospective study	jejunostomy feeding tube placement (laparoscopically assisted)	right lateral	3-port technique: telescope port dorsal Instrument portals: cranioventral and caudoventral	11–15

With this technique, access to the jejunum is established laparoscopically and the jejunum is pulled out of the abdominal cavity. The feeding tube is then placed extracorporeally. Rawlings et al. (2002a) performed duodenostomy tube placement and biopsy of the jejunum in dorsal recumbency. Two ports were used, the telescope port was placed midline 2 to 3 cm caudal to the umbilicus and the instrument port lateral to the right rectus abdominis muscle in the mid abdomen. For jejunal biopsy a second instrument port was placed on the opposite side of the first instrument port (Rawlings et al. 2002a).

For jejunostomy tubes a right lateral recumbency was used to avoid a deteriorated view because of the falciform ligament (Hewitt et al. 2004).

A three-port technique was described, but there is no detailed information about the port placements. The telescope port was placed ventral to the epaxial muscles and the instrument ports caudal to the last rib and cranial to the pubis. The authors recommended insertion of the tube into the duodenum instead of the jejunum, this would require only two ports and decrease intestinal manipulation (Hewitt et al. 2004).

3.25. Jejunostomy For Fecal Diversion

Table 26: Jejunostomy for fecal diversion

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Chandler et al.	2005	case report	jejunostomy or fecal diversion (laparoscopically assisted)	ventral	3-port technique: telescope 2 to 3 cm caudal to the umbilicus, Instrument portals: first 3 cm cranial to the umbilicus and second paramedian on the right 3 cm lateral to the midline	14

Access to the jejunum is established laparoscopically and the jejunum at the location of the jejunoileal junction is pulled out of the abdominal cavity. The jejunum is incised and sutured to the abdominal wall to create a stoma. In one case, dorsal recumbency with a three-port technique was reported, with the telescope 2 to 3 cm caudal to the umbilicus and the instrument ports paramedian 3 cm lateral to the midline (first) and 3 cm cranial to the umbilicus (second) on the right side of the abdomen (Chandler et al. 2005).

3.26. Laparoscopically Assisted Ileocecectomy

Table 27: Laparoscopically assisted ileocecectomy

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Cho et al.	2011	experimental study	Ileocecectomy (laparoscopically assisted)	Trendelenburg, tilted to the left	umbilical multiport	<10

With the help of the laparoscopic instruments, access to the caecum is created. The caecum is then moved out of the abdominal cavity. The caecum and parts of the ileum are removed. The literature search revealed one experimental study with information of a Trendelenburg recumbency and an umbilical single multiport for this procedure (Cho et al. 2011). In this study a magnetic anchoring system was used to lift up the caecum.

3.27. Laparoscopically Assisted Foreign Body Removal/Intestinal Resection

Table 28: Laparoscopically assisted foreign body removal/intestinal resection

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Otomo et al.	2019	retrospective study	foreign body removal (laparoscopically assisted)	dorsal	subumbilical multiport	10–12
Gower and Mayhew	2011	case series	intestinal resection (laparoscopically assisted)	dorsal	2-port technique: telescope port subumbilical Instrument port either between the xiphoid process and umbilicus or between the umbilicus and pubis depending on the anticipated location of the mass.	10–15

Access to the intestine is created with laparoscopic instruments. The part of the intestine with the area of interest is then pulled out of the abdominal cavity and incised or excised. Foreign mass removal or intestinal resection is described in dorsal recumbency (Gower and Mayhew

2011, Otomo et al. 2019). A two-port technique was used by Gower and Mayhew (2011), the telescope port was placed midline subumbilically and the instrument port was positioned either between the umbilicus and pubis or between the xiphoid process and umbilicus, depending on the point of interest. However, Otomo et al. (2019) performed the mass removal through a single multi-port caudal to the umbilicus.

3.28. Medial Iliac Lymph Node Excision

Table 29: Medial iliac lymph node excision

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Steffey et al.	2015	experimental study	lymph node extirpation (medial iliac)	lateral (contralateral side)	3-port technique: telescope port lateral abdominal wall Instrument portals: 3 to 5 cm cranial and caudal to the camera portal (following the rules of triangulation)	10
HyunJoo et al.	2017	case series	lymph node extirpation (medial iliac)	Trendelenburg (15°), 30° lateral tilt for each side	3-port technique: telescope port: 3 cm craniolateral to the umbilicus at the level of the last ribs Instrument portals: first port at a point equidistant from the midline and the camera portal on the contralateral side. Second portal in the caudal abdomen at a location approximately one third of the distance between the pubic bone and the instrumental portal.	10–15

With the help of the laparoscopic instruments, access to the medial iliac lymph node is created and is then dissected out and removed. For this specific procedure two recumbencies, a 15° Trendelenburg with 30° lateral tilt and a lateral position on the unaffected side, are described (Steffey et al. 2015, HyunJoo et al. 2017).

HyunJoo et al. (2017) used three ports, the telescope port was placed 3 cm craniolateral to the umbilicus at the level of the 13th rib in the upper right abdomen. The first instrument port was placed at a point equidistant from the midline and the camera portal on the contralateral side of the animal under laparoscopic guidance, the third portal was positioned one third of the distance between the pubic rim and the ipsilateral instrument portal (HyunJoo et al. 2017).
In the experimental study Steffey et al. (2015) applied a technique with three ports in lateral recumbency. The telescope port was located directly ventral to the cranial aspect of the iliac wing, at the approximate dorsoventral midpoint to lower third of the abdomen. The two instrument portals were located 3 to 5 cm cranial and caudal to the camera portal, level with the camera port or slightly dorsal to it (Steffey et al. 2015).

3.29. Laparoscopic Fluorescence Lymphography

Table 30: Laparoscopic fluorescence lymphygraphy

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)
Sánchez-Margallo	2020	experimental study	fluorescence lymphography	Trendelenburg	3-port technique: telescope at the umbilicus. Instrument portals: caudal to telescope and lateral on each side (only drawing)	12

In an cadaveric study Sánchez-Margallo et al. (2020) did perform fluorescence lymphography with Indocyanine green administrated intradermal in the flank region and comparatively in the popliteal lymph node. The authors assessed time and quality of the staining of the lymphatic structures. The ports were not described in detail, but the telescope port was placed at the umbilicus and the two instrument ports, based on the rules of triangulation, caudal to the telescope and lateral on each side (Sánchez-Margallo et al. 2020).

3.30. Cisterna Chyli Ablation

Table 31: Cisterna chyli ablation

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)

Sakals et al.	2011	experimental study	cisterna chyli ablation	sternal recumbency with the pelvis elevated	2-port technique: Transdiaphragmatic group: telescope portal was placed in the dorsal third of the left 10th or 11th intercostal space, instrument portal slightly more dorsal. Abdominal group: portals were placed 2 to 3 cm caudal to the 13th rib on the left side in the dorsal third of the abdomen	6–10 (trans-diaphragmatic group) 10 (abdominal group)
Morris et al.	2019	cadaveric and retrospective study	cisterna chyli ablation	sternal recumbency with a sandbag under the pubis.	combination of thoracic ports and a single multiport at left or right flank approximately 2 cm caudal to the last rib	-

The cisterna chyli is an enlargement of the lymphatic vessels at the caudal end of the thoracic duct. With laparoscopic techniques this organ can be visualized and ablated. In cadaveric and experimental studies cisterna chyli ablation was performed in sternal recumbency with the pelvis elevated to achieve a horizontal position of the spine (Sakals et al. 2011, Morris et al. 2019). (Sakals et al. 2011) compared a transdiaphragmatic and an abdominal approach. The transdiaphragmatic access was gained by a telescope port in the dorsal third of the 10th or 11th intercostal space and an instrument port with was inserted slightly more dorsal. For the abdominal group two ports were placed 2 to 3 cm caudal to the 13th rib on the left side in the dorsal third of the abdomen. The telescope was inserted in the caudal port and the cranial port was used for instruments (Sakals et al. 2011). Morris et al. (2019) used a combination of two thoracic ports and a single multiport was inserted 2 cm caudal to the last rib at the left or right flank.

3.31. Biopsies

Table 32: Biopsies

Author	Date	Study type	Procedure	Recumbency	Port placements	Intra-abdominal pressure (mmHg)

Richter	2001	review	biopsy of liver/kidney and laparoscopically assisted the intestinal tract	Liver: left oblique (45°) Kidney: lateral (with affected side up) Intestinal tract: dorsal, or depends on point of interest, with the lesion as close to the body wall as possible	Liver: telescope just below the lumbar muscles in the right flank, biopsy instrument just lateral to the xiphoid cartilage Kidney: telescope caudal to the umbilicus and a few centimeters lateral to midline toward the kidney, location of instrument port not described Intestinal tract: 3-port technique: telescope at the umbilicus; instrument ports few centimeters lateral to it on each side	<15
Rawlings et al.	2002	experimental study	tube, enterostomy tube placement, jejunum biopsy with serosal patch	dorsal	2 to 3-port technique: midline telescope port 2 to 3 cm caudal to the umbilicus Instrument ports: first port lateral to the right rectus abdominis muscle in the midabdominal area. Second port for jejunal biopsy at the same location on the left side.	-
Barnes et al.	2006	experimental	biopsies (left adrenal gland, liver, spleen, pancreas, GIT, bladder	dorsal, 45° for left adrenal gland	3-port technique: standard technique with an 11mm cannula inserted just caudal to the umbilicus and two 11mm screw- type cannulas (were inserted in paramedian locations, lateral to the third mammary glands.	-

Mayhew	2009	review report	biopsies (liver, kidney, GI, pancreas)	dorsal, lateral for individual biopsies	2 to 3-port technique: Telescope port subumbilical. Liver: instrument port in paramedian position in either the right or left cranial abdominal quadrant. Second port if needed for haemostatic devices on contralateral side. Kidney: instrument port can be placed on the ventral midline 5 to 10 cm cranial or caudal to the telescope port. Pancreas: one or two ports, if needed for haemostatic devices	-
Rothuizen and Twedt	2009	review	biopsy liver	dorsal/left lateral	Multiport behind the umbilicus (dorsal recumbency) Multiport in the mid right abdominal wall (left lateral recumbency)	-
Freeman	2009	review	liver, pancreas, kidney	dorsal or left lateral for liver, dorsal for both kidney, lateral for one kidney	telescope port just caudal to the umbilicus (dorsal recumbency); telescope port halfway between the last rib and the ilium and midway between the spine and ventral midline (lateral recumbency) Kidney: ventral midline port placement (both kidneys)	-
Petre et al.	2012	retrospective case series	biopsy liver	dorsal	2-port technique: midline telescope port 2 to 3 cm caudal of umbilicus.	<12

					Instrument port paramedian on the right side	
Radha-krishnan and Mayhew	2013	case series	biopsy spleen	dorsal	2-port technique: telescope port caudal of umbilicus Instrument port 3 to 5 cm cranial of the umbilicus	-
Milovancev and Townsend	2015	review	biopsy spleen/kidney/GIT, splenectomy, nephrectomy, ovariectomy, ovariohysterectomy, cryptorchidectomy, adrenalectomy, cisterna chyli ablation, lymph nodes extirpation cholecystectomy, portosystemic shunt, calculus removal cystoscopic	depends on procedure	Liver: 2 to (3)-port technique: midline telescope port, right or left cranial quadrant and if needed third port paramedian instrument portal, second instrument port on the contralateral side for a vessel sealing device Spleen: ventral or left lateral midabdominal multiport Lymph nodes extirpation: 3-port technique: in the lateral caudal abdominal wall for the ipsilateral lymph nodes Kidney: midline port placement Gastrointestinal biopsy: standard midline portals	-
McDevitt et al.	2016	case series	biopsy liver	dorsal, to improve visualization, moving patient in various positions	Single multiport: umbilical 2-port technique: telescope at the umbilicus or caudal to it Instrument portal: 3 to 5 cm lateral to the midline in the left or	8–10

					right cranial abdominal quadrant.	
Shamir et al.	2019	retrospective study	abdominal exploration, biopsies	dorsal, 45° to the side	1-port technique: midline 1 cm caudal to the umbilicus 2-port technique (for biopsies): same telescope port, instrument port cranial or caudal to it or 2 to 4 cm lateral to the telescope port	8–12

Biopsies are an important part of laparoscopic surgery. With the help of laparoscopic instruments samples of the organs in the abdomen are taken for further diagnosis.

3.31.1 Liver

To take biopsies of the liver most authors prefer to place the dogs in dorsal recumbency, with a telescope port or multiport umbilical or just caudal to the umbilicus (Barnes et al. 2006, Mayhew 2009, Rothuizen and Twedt 2009, Buote et al. 2011, Petre et al. 2012, McDevitt et al. 2016, Shamir et al. 2019). In these studies, the instrument ports were placed in a right paramedian position, with the exception of Buote et al. (2011) positioning the instrument port cranial to the telescope port. Richter (2001) described in his review a left oblique recumbency with the telescope port in the right flank below the lumbar muscles and the instrument port lateral to the xiphoid cartilage. A right lateral approach is also described by Monnet and Twedt (2003). (Mayhew 2009) also recommended placing the port on the left side and adding a second instrument port on the contralateral side, for a haemostatic device, if needed. Barnes et al. (2006) used a three-port technique with the instrument ports also placed paramedian, lateral to the third mammary gland on each side to collect specimens of all parenchymal organs. Rothuizen and Twedt (2009) also describe a left lateral recumbency with the telescope port placed in the right mid-abdominal wall to avoid the falciform ligament. Freeman (2009) described a subumbilical initial port for lateral and for lateral recumbency a location halfway between the last rib and the ilium and midway between the spine and ventral midline in her review.

3.31.2 Kidney

For laparoscopic biopsies of the kidney dorsal recumbency is used (Mayhew 2009, Shamir et al. 2019). Mayhew (2009) recommended placing a subumbilical telescope port, an additional instrument port can be placed on the ventral midline 5 to 10 cm cranial or caudal to the telescope port. (Shamir et al. 2019) used the same ports as described above for liver biopsy. Aside from the dorsal recumbency (Milovancev and Townsend 2015) mentioned a slightly rotated position to the side with the affected side up and the portals placed midline, or in a midabdominal location. To biopsy both kidneys a dorsal recumbency with a ventral midline port placement, and a lateral recumbency for single kidney biopsy, is also described by Freeman (2009). Richter (2001) delineated a lateral recumbency with the kidney of interest on the upper side and the telescope port caudal to the umbilicus a few centimetres towards the kidney.

3.31.3 Spleen

Dorsal recumbency is described to collect splenic samples (Barnes et al. 2006, Radhakrishnan and Mayhew 2013). For this procedure (Radhakrishnan and Mayhew 2013) inserted the subumbilical telescope port and the instrument port 3 to 5 cm cranial to the umbilicus. (Barnes et al. 2006) used the same three-port technique which was described earlier for liver biopsies.

3.31.4 Adrenal Gland

In an experimental study the dogs were positioned in a 45° laterally tilted position for the biopsy of the adrenal gland (Barnes et al. 2006). Ports were the same as earlier described for liver biopsy.

3.31.5 Jejunum (Laparoscopically Assisted)

The literature search yielded one experimental study and one review from 2001 with the dogs in dorsal recumbency. A three-port technique was used with the telescope midline 2 to 3 cm caudal to the umbilicus, the instrument ports were placed lateral to the right rectus abdominis muscle in the midabdominal area on both sides (Rawlings et al. 2002a). The review of Richter (2001) reports a dorsal position used, or a position in which the focal point of interest comes as close as possible to the body surface. A three-port technique is described with the telescope at the umbilicus and the instrument ports a few centimetres lateral on each side of the abdomen (Richter 2001).

3.31.6 Pancreas

For pancreatic biopsies a median or right lateral approach is used (Monnet and Twedt 2003, Barnes et al. 2006, Milovancev and Townsend 2015). Barnes et al. (2006) documented a standard midline three port access for biopsies of several abdominal organs including the pancreas. One instrument port for a punch biopsy technique, or if needed a second instrument port, for a vessel sealing device, are described (Mayhew 2009).

4. Discussion

4.1. Abdominal Exploration

A basic abdominal exploration should be performed ahead of the actual procedure and is usually done in dorsal recumbency (Case and Ellison 2013, Wright et al. 2016, Barry et al. 2017). Tilted positions of 45° to the side are described, which help with the examination of abdominal organs (Wright et al. 2016, Barry et al. 2017).

The liver can be accessed with a single port between the umbilicus and the xiphoid in dorsal recumbency. If difficulties occur in visualisation and examination of the liver, a reverse Trendelenburg recumbency or a lateral recumbency can be helpful (Oramas et al. 2019).

The current literature describes a dorsal position for a basic examination of the abdominal cavity. An optical port close to the umbilicus seems to be the best position for abdominal exploration (Maiti et al. 2008, Case and Ellison 2013, Barry et al. 2017).

To explore all aspects of the abdomen thoroughly, a combination of different recumbencies (as described above) and the use of a blunt probe to palpate and manipulate the abdominal organs is applied (Barry et al. 2017). More studies are needed to evaluate the most practical way to perform a quick and complete abdominal exploration.

4.2. Ovariectomy/Ovarian Remnant Removal

Procedures of the genital tract are playing a big role in laparoscopic procedures at the moment. The results of the literature research can be seen in Table 3 and Table 4

It seems, that a laterally tilted position to allow the abdominal organs fall on the contralateral side, enables the best view on the ovaries (Van Goethem et al. 2003, Nickel et al. 2007, Gower and Mayhew 2008, Dupré et al. 2009, Manassero et al. 2012, Runge et al. 2012, 2014a, Naiman et al. 2014, Liehmann et al. 2018, Van Nimwegen et al. 2018). Liehmann et al. (2018) describe that tilting the dog laterally by 45° results in significant improvement of ovary identification rate in comparison to 0° and 22,5° tilted positions. A better visualization was accomplished by starting with the left ovary and tilting the dogs to the right side first, because the spleen subsequently didn't obstruct the view on the ovaries (Liehmann et al. 2018)

Placing dogs in a Trendelenburg position supports a cranial displacement of the genital tract and increases the view by movement of the intestines away from the genitourinary tract (Nickel et al. 2007, Gower and Mayhew 2008).

As shown in Table 3 and Table 4 (above), standard two or three-port midline techniques are widely used. The midline technique is optimal for visualization of the ovaries, due to their lateral position close to the abdominal wall (Kuhn and Kampmann 2015).

However, a single multiport close to the umbilicus is an alternative to the standard techniques. Fewer ports can result in reduced postoperative pain (Case et al. 2011). A downside of single port techniques is the limited triangulation and range of motion (Manassero et al. 2012). The single port technique also allows working without an assistant and having the instruments in the same plane of the laparoscope can result in greater control of the instruments (Dupré et al. 2009). Although instrument interference can occur, single port technique can be performed with standard laparoscopic equipment (Runge et al. 2012). In human medicine angled laparoscopic instruments are used for this specific purpose, which are not widely used yet in veterinary medicine. Runge and Mayhew (2013) found that ovariectomy with a single port access with angled instruments was a safe, feasible procedure in dogs.
It depends on the surgeons, their experience and the provided equipment, which recumbency and which access should be selected. Based on the results of Liehmann et al. (2018), a 45° degree lateral recumbency seems to be best for rapid identifying of the ovary.

4.3. Ovariohysterectomy

Trendelenburg position and dorsal recumbencies are both listed in Table 5. A benefit of the Trendelenburg position is, that it facilitates cranial displacement of the visceral organs and improves exposure of the uterine body (Austin et al. 2003, Gower and Mayhew 2008, Berenjian et al. 2010). Authors described that laterally tilted recumbency provides good visibility of the ovaries as also depicted above for OVE (Gower and Mayhew 2008, Sánchez-Margallo et al. 2015).
Most of the authors above describe a three-port technique which provides an adequate number of ports (Austin et al. 2003). However, an umbilical approach enables exploration and subsequent surgical interventions without complications. The use of a multi-trocar port allows excellent visualization and adequate working space (Sánchez-Margallo et al. 2015). Because of the anatomical circumstances, the best location to place the ports is the central midline of the abdominal wall (Kuhn and Kampmann 2015).
LAOHE is a viable alternative to the open approach. The ability to get close to the target structures is beneficial as well as bright illumination by the included light source. Furthermore, Hancock et al. (2005) have shown that laparoscopic procedures result in reduced postoperative pain and stress in comparison to standard OVH.
LAOHE is a feasible surgical technique, dorsal recumbencies or Trendelenburg positions are widely used. Whether a single-port technique or a technique with several ports should be used in order to achieve adequate results can be further investigated. But it also depends on the surgeon's personal preferences and skills.

4.4. Laparoscopically Assisted Ovariohysterectomy

LAOHE is performed in dorsal recumbency with lateral rotation for the ovaries, as can be seen in Table 6. Lateral rotation of the patients swiftly enables identification of the ovaries and the uterus (Devitt et al. 2005).

Compared to healthy reproductive organs, pathologically changed organs such as pyometra cannot be handled laparoscopically. Adamovich-Rippe et al. (2013) described that a three-port technique provided excellent manipulation of the uterine horns and ovaries. Mayhew and Brown (2007) also found that their three-port access, shortly described in Table 6, ensured good working space for this procedure. Exteriorization of the uterus can be easily carried out through the caudal port (Mayhew and Brown 2007, Niranjana et al. 2013).

On the contrary, Wallace et al. (2015) described in a cohort study, that single port access is feasible for treatment of pyometra and mucometra which strict case selection beforehand only (uterine body diameter less than 5 cm). In a study by Becher-Deichsel et al. (2016), pyometras up to 7 cm were successfully performed through a multiport created with a surgical glove and an additional port for the cautery device. This low-cost alternative seems to be a feasible technique and can be used in veterinary practice. Potential downsides on the three-port technique by Adamovich-Rippe et al. (2013) are expenses and the need for assistance during the procedure. For single port techniques, adequate placement of the port is critical for exteriorizing the uterine body (Wallace et al. 2015). Wallace et al. (2015) mentioned that removal of the uterus is complicated by a port placed too far cranial, whereas instrument articulation is more difficult by a port placed too far caudal. Lopez et al. (2017) furthermore suggested to place a second port on the ventral midline to aid in retraction of the ovary if difficulties should occur. Adamovich-Rippe et al. (2013) and Wallace et al. (2015) both described laparoscopically assisted Ovariohysterectomy as a feasible technique for select cases of uterine pathologies. The choice of whether a single or for example a three-port technique depends on the surgeon preferences and training.

4.5. Gastropexy

According to the literature dorsal recumbency for laparoscopic gastropexy is the most common position (Mathon et al. 2009, Spah et al. 2013, Stiles et al. 2016). Fox-Alvarez et al. (2016) and Takacs et al. (2017) performed the procedure in dorsal recumbency with a tilt to the left. Unfortunately, the authors did not elaborate on the quality of visualization afforded by this recumbency.

A three-port technique is widely used to get access to the stomach (Mathon et al. 2009, Spah et al. 2013, Allen and Paul 2014, Takacs et al. 2017). (Takacs et al. 2017) performed gastropexy through a SILS port and an additional port in a group of 15 dogs. In two dogs, a

second port was needed, due to insufficient triangulation. In this case, angled instruments could evade the use of a second port. Nevertheless, the use of single or multi-port devices could make the procedure even less invasive (Runge and Mayhew 2013, Stiles et al. 2016). Another interesting point would be to examine the combination of gastropexy and ovariectomy more closely. However, reverse Trendelenburg position and a position with the dog tilted to the left will be beneficial to help visualisation and manipulation of the stomach. The difference between deep chested and normal chested dogs could be relevant for this procedure.

4.6. Laparoscopically Assisted Gastropexy

Dorsal recumbency for laparoscopic gastropexy is the most used position (Rawlings et al. 2001, 2002a, Balsa et al. 2017). Reverse Trendelenburg position can be added to provide caudal displacement of the organs (Rivier et al. 2011). In laparoscopic assisted gastropexies a two-port access, as described in the results is mainly performed. In the author's opinion, the placement of the ports is not as crucial as in comparison to a pure laparoscopic technique. That could also be the reason why there is little detailed information about the position of the ports.

4.7. Pyloroplasty (Pursuant Finney)

The literature search revealed only one paper by Sánchez-Margallo et al. (2007), they describe a laparoscopic Finney procedure to treat chronic duodenal ulceration and pyloric hypertrophy. However, their study had an experimental setting with a very small patient number of six dogs. More information about feasibility in clinical patients and long-term-outcome would be interesting.

4.8. Splenectomy

For this procedure a standard dorsal recumbency was widely used, described in the results in Table 10 (Al-Hasan and Al-Heam 2009, Stedile et al. 2009, Collard et al. 2010, Shaver et al. 2015).

Stedile et al. (2009), Bakhtiari et al. (2011) and Khalaj et al. (2012) documented a 30° or 45° tilted position to the side. Whereas other authors preferred a right lateral recumbency (Shaver et al. 2015, TaeYeong et al. 2016). It cannot be concluded from the findings which of the laterally tilted positions is the best, but these recumbencies seem to provide adequate exposure of the vessels including those at the dorsal extremity (Stedile et al. 2009, Bakhtiari et al. 2011, Shaver et al. 2015). Rotation to a left lateral recumbency improved the view on the splenic vessels, whereas rotation to a right lateral recumbency enabled good visualization of the vessels on the dorsal extremity and gastrosplenic ligament (Shaver et al. 2015).

In general, three ports are placed either in midline, as described in the results in Table 10, or in positions based on the rules of triangulation (Al-Hasan and Al-Heam 2009, Stedile et al. 2009, Collard et al. 2010, Bakhtiari et al. 2011, Khalaj et al. 2012, Shaver et al. 2015, TaeYeong et al. 2016). However, a single port technique could be a viable alternative to multiport splenectomy (Khalaj et al. 2012). This has the potential for a reduction of surgery time, number of incisions, analgesic requirement, length of hospital stay and decreased risk for incision-related injuries of abdominal organs.

Laparoscopic splenectomy can be performed safely and quickly in dorsal recumbency, or if a better view on the dorsal part of the hilus is needed, in a tilted position to the right. The spleen is an organ which is easily approached. A downside on the laparoscopic technique is that larger or congested spleens or large splenic masses cannot easily be retrieved with a retrieval bag due to size. But the laparoscopic approach could still be useful for dogs with non-neoplastic splenic disease and small splenic masses (TaeYeong et al. 2016).

The tendency in modern medicine is to be less invasive, so the most interesting parts regarding this procedure are the number and location of the ports. The literature research revealed only one publication where a single port was documented, there is further investigation needed for discussing single port accesses for splenectomy.

4.9. Laparoscopically Assisted Splenectomy

Laparoscopically assisted splenectomy is based on the same principles as laparoscopic splenectomy. Lateral rotation of 45° of the patients enables maximal visualization of the abdominal organs (Wright et al. 2016). More data is needed to conclude the optimal recumbency and port placement for this procedure.

4.10. Adrenalectomy

For adrenalectomy mainly recumbencies are reported varying between sternal and lateral positions. Semilateral recumbency with a raised spine is described, which allows displacement of the abdominal organs (Jiménez Peláez et al. 2008, Milovancev and Townsend 2015, Pitt et al. 2016). Sternal recumbency also allows ventral displacement of the abdominal organs with provides a good view on the adrenal glands (Naan et al. 2013, Milovancev and Townsend 2015, Jeong et al. 2016).

A minimum of three ports is needed, but often a fourth port was inserted, and they are always placed following the rule of triangulation (Jiménez Peláez et al. 2008, Naan et al. 2013, Mayhew et al. 2014, Pitt et al. 2016). Laparoscopic adrenalectomy is an upcoming technique

with the optimal position not being developed yet. Pitt et al. (2016) and Mayhew et al. (2014) used a similar technique with three or four ports. Further evaluation of recumbencies and port techniques is needed, there are contentious opinions about this.

4.11. Nephrectomy

Laparoscopic nephrectomy was only applied in experimental studies yet. Dorsal recumbency as well as with a 60° - 80° rotation to the side is documented (Kim et al. 2013, Mayhew et al. 2013, Shariati et al. 2014, Hartmann et al. 2018). In these experimental studies three or four ports were established, described above in the results.

At this state no recommendation for a specific recumbency can be made, it seems that a lateral recumbency allows good visibility of the kidney. This relative new procedure needs further investigation with clinical studies, laparoscopic nephrectomy could be beneficial in several points.

4.12. Cholecystectomy

Dorsal recumbency with four ports is described and several cases are reported (Mayhew et al. 2008, Milovancev and Townsend 2015). A telescope position caudal to the umbilicus reveals good observation of all structures. If four ports are used, the instrument portals should be inserted based on the rules of triangulation around the gall bladder. It isn't mandatory to place the instrument ports at an exact position (Mayhew et al. 2008). But in one experimental study the procedure was successfully performed with a single multiport technique (Lee et al. 2011). The telescope placement is nearly identical resulting in similar visibility.
The single port technique seems to have a potential to be less invasive in selected cases, the dorsal recumbency in combination with the telescope port at the umbilicus seems to provide good visibility of the gall bladder.

4.13. Cholecystostomy/Cholecystoduodenostomy

Both studies, which were discovered through the literature search, were experimentally performed on cadavers and need further investigation to evaluate an applicable approach and technique for these procedures (Murphy et al. 2007, Martín-Portugués et al. 2016).

4.14. Cholecystocentesis

The literature search revealed only one paper by Shamir et al. (2019), more research needs to be done to discuss this procedure.

4.15. Portosystemic Shunt Attenuation

The successfully procedure which was performed in dorsal recumbency with four ports is indeed an argument for doing more research on this topic (Miller and Fowler 2006).

4.16. Cryptorchidectomy

Dorsal or lateral as well as Trendelenburg position is described in the literature (Spinella et al. 2003, Runge et al. 2014b). A subumbilical multiport enables access to the entire caudal abdomen. In some cases, a similar technique like in ovariectomy was used by tilting the dogs to the side to expose the affected testis, which seems to be a good option (Runge et al. 2014b).

4.17. Laparoscopically Assisted Cryptorchidectomy

Dorsal and tilted recumbencies are also applied in laparoscopic assisted procedures (Miller et al. 2004, Urbanová et al. 2010). For me it is not clear, which position reveals the best results for cryptorchidectomy. This could be due to the variety of locations of the testicles.

4.18. Vas Deferentopexy

For this rarely performed surgery, the literature search revealed only one publication. More research needs to be done, to discuss this topic.

4.19. Laparoscopically Assisted Colopexy

The literature search showed up only two publications summarized in Table 22, with no additional information about the consequents of the recumbency. More information is needed for further discussion of the topic.

4.20. Cystopexy

The search revealed one cadaveric study, a three-port technique performed in 15° Trendelenburg position with a lateral tilt is described (Alvarez et al. 2015). No information was documented regarding to effects of recumbency or port placement.

4.21. Laparoscopically Assisted Cystic Procedures

The laparoscope is mainly used to assist cystotomy and urolith removal. In most of the papers, which are listed in Table 24, Trendelenburg recumbency is used. This recumbency enables the urinary bladder to fall as cranial as possible and allows a cranial displacement of the abdominal organs (Zhang et al. 2010, Pinel et al. 2013). Two or three port techniques were performed in the listed studies. In the author’s opinion port placement especially for these laparoscopic assisted procedures is not as relevant, as the recumbency of the animal itself.

4.22. Laparoscopically Assisted Feeding Tubes

Placing duodenostomy or jejunostomy feeding tubes are an advanced approach for enteral nutrition. The literature search revealed two publications which are listed in Table 24. Rawlings et al. (2002a) performed the placement of the feeding tube in dorsal recumbency, whereas Hewitt et al. (2004) used a right lateral recumbency to avoid the falciform ligament. From my perspective, a dorsal recumbency seems to be sufficient, but more research needs to be done to evaluate the error rate of a deteriorated view of the falciform ligament.

4.23. Jejunostomy For Fecal Diversion

Result of the literature search was only one case report which can be seen in Table 27. The procedure was performed in dorsal recumbency with a standard midline 3 port approach. More information is needed to discuss this method**.**

4.24. Laparoscopically Assisted Ileocecectomy

Ileocecectomy is rarely performed in veterinary medicine. Consequently, the literature search results in only one experimental study by (Cho et al. 2011). No information about the effects of positioning was documented. A magnetic anchoring system was used to lift up the caecum for adequate exposure.

4.25. Laparoscopically Assisted Foreign Body Removal/Intestinal Resection

In Table 28 can be seen, that Otomo et al. (2019) and Gower and Mayhew (2011) conducted their procedure in dorsal recumbency. A single multiport seems to be sufficient for this purpose. In my view it depends on the skills of the surgeon if these procedures can be performed through a single multiport.

4.26. Medial Iliac Lymph Node Excision

The two papers listed in Table 29 both offer a detailed description for the experimental access to the medial iliac lymph node. Steffey et al. (2015) did point out that with the lateral approach, the contralateral lymph node could not be identified, whereas the portal configuration was considered to be suitable for the targeted lymph node. A consequence of that finding is, that repositioning and additional ports are necessary to remove the contralateral lymph node (Steffey et al. 2015). HyunJoo et al. (2017) also described this limitation for their approach.
An open approach may still be the more practical approach if removal of both lymph nodes is required (Steffey et al. 2015). Further research is needed to find out the optimal approach.

4.27. Laparoscopic Fluorescence Lymphography

In the publication of Sánchez-Margallo et al. (2020), the main focus was on recording the data time and quality of the staining of the structures. No technique for surgery was treated, so there is no subject for discussion.

4.28. Cisterna Chyli Ablation

According to the papers in Table 31, this procedure is still rarely performed in veterinary medicine. It seems that sternal recumbency with sandbags or cushions for level position of the spine is common. There are several accesses described and combinations of abdominal ports and thoracic ports are used. The techniques described by Sakals et al. (2011) in an experimental study, resulted in a successful ablation of the cisterna chyli. With the transdiaphragmatic approach there is a risk of iatrogenic diaphragmatic hernia and tension pneumothorax. Using the abdominal approach, on the contrary, there is negligible risk for diaphragmatic trauma, but additional manipulation can be necessary because of an obscured view by perirenal fat. Also, the handling of the instruments is more difficult because of the lack of triangulation (Sakals et al. 2011). A modified technique described by Morris et al. (2019) enables lymphangiography and laparoscopic cisterna chyli ablation through a single flank port in combination with thoracic ports in cadavers and in clinical cases. Their right-sided approach results in quick visualization of the colic lymph node, but the drawback for this approach is the anatomical position of the abdominal vena cava, which can block the view on the cisterna chyli (Morris et al. 2019). Due to the deep location within the retroperitoneum the laparoscopic approach for these procedures seems to be very promising and further investigation about the feasibility in clinical patients is warranted.

4.29. Biopsies

4.29.1 Liver

As can be seen in the Table 32, a two or three port technique is widely used with the dog in dorsal recumbency. Placing the telescope just caudal to the umbilicus enables a total visualization of the liver (Rothuizen and Twedt 2009). Rothuizen and Twedt (2009) also describe a left lateral recumbency with the telescope port placed in the right mid-abdominal wall to avoid the falciform ligament, but with the downside of getting a worse view on the left lateral lobe. Tilting the patient in lateral positions or in Trendelenburg or reverse Trendelenburg recumbency enables complete examination of the liver (McDevitt et al. 2016). To investigate more than 85% of the liver, extrahepatic biliary system, and right limb of the pancreas a right lateral approach is recommended (Monnet and Twedt 2003). Also, a less invasive single multiport approach is described in a large case study with successful outcome (McDevitt et al. 2016). This furthermore leads to the question if a single multiport access is sufficient.

4.29.2 Kidney

For biopsy of the kidney, the literature search revealed only a few articles. As you can see in Table 32, mainly dorsal recumbency but with different port placements is described. Also, the same ports as for liver biopsies are described in one paper (Shamir et al. 2019). Furthermore, Monnet and Twedt (2003) described a left lateral approach to be more difficult, because of the spleen on the left side of the abdominal wall. A good view on the right kidney can be achieved with a right lateral midabdominal telescope approach. There are a few publications listed in Table 32, dealing with the experimental topic of nephrectomy. It would be interesting to combine the techniques used in these studies in a uniform study population.

4.29.3 Spleen

The literature search results in only two papers, which are also listed in Table 32. Two different approaches in dorsal recumbency are described. Barnes et al. (2006) the same access points as described earlier for liver biopsies. Ports and recumbencies for splenectomy are described above in chapter 4.8. More research needs to be done for this procedure, including a comparison between splenectomy and splenic biopsies.

4.29.4 Adrenal Gland

Only one paper described a laparoscopic biopsy technique for the adrenal glands, see Table 32. Much more information can be collected by looking at papers that discuss laparoscopic adrenalectomy.

4.29.5 Jejunum (Laparoscopically Assisted)

A three-port technique in dorsal recumbency is only described in one paper (Rawlings et al. 2002a). Due to the mobility of the jejunum this procedure can be performed in addition to nearly every other laparoscopic procedure.

4.29.6 Pancreas

As previously listed in Table 32, a median or right lateral approach is used for pancreatic biopsy. Exploration of the pancreas laparoscopically can be challenging due to lack of tactile information and the deep anatomic location of the left pancreatic limb. More research needs to be done to evaluate the optimal positioning of the dogs for a fast and save procedure.

5. Summary

The aim of this work was to reflect the current state of science (period 2000 to 2020) and to collect data on the positioning and the respective laparoscopic access. In order to get an overview of the current literature, a comprehensive literature search was performed in order to include relevant publications in the field of abdominal laparoscopic surgery. Criteria were drawn up in advance that decided whether the respective publication should be included in the review or not. These criteria can be seen in Tab. 1.

The primary focus has been on abdominal laparoscopic surgical articles. After reading the articles, they were summarized and categorized in a table.

These results were discussed with the help of the authors' descriptions and recommendations for positioning and access.

Based on the results, it can be concluded that there is still a lot of research to be done in the field of laparoscopic surgery. Comparative prospective studies would be interesting for the surgical techniques that are already often practiced in practice, such as ovariectomy or splenectomy. There is still a lot of research to be done on other less well-established techniques. Unfortunately, positioning, exact access points and insufflation pressures are frequently not described exactly or not at all.

On the whole, this work provides an overview of the current study situation in laparoscopic surgery. Building on this, individual chapters can hopefully now be examined more closely, or existing gaps explored.

6. Zusammenfassung

Das Ziel dieser Arbeit war es den aktuellen Stand der Wissenschaft (Zeitraum 2000 bis 2020) wiederzugeben und Daten über der die Lagerung und die jeweiligen laparoskopischen Zugänge zu sammeln. Um einen Überblick über die aktuelle Literatur zu bekommen, wurde eine umfassende Literaturrecherche betrieben, um relevante Publikationen auf dem Gebiet der abdominalen laparoskopischen Chirurgie zu erfassen. Im Vorfeld wurden Kriterien erstellt, welche darüber entschieden, ob die jeweilige Publikation in die Arbeit inkludiert wird oder nicht. Diese Kriterien sind in Table 1 ersichtlich.

Das primäre Augenmerk wurde auf chirurgische Artikel der abdominalen laparoskopischen Chirurgie gelegt.

Nach dem Lesen der Artikel wurden diese in einer Tabelle zusammengefasst und kategorisiert. Diese Ergebnisse wurden mit Hilfe der Beschreibungen und Empfehlungen von Lagerung und Zugängen der Autoren diskutiert.

Anhand der Ergebnisse lässt sich darauf schließen, dass noch viel Forschungsbedarf im Gebiet der laparoskopischen Chirurgie besteht. Bei den Operationstechniken, welche bereits in der Praxis oft praktiziert werden, wie zum Beispiel die Ovariektomie oder die Splenektomie, wären Vergleichsstudien interessant. Bei anderen, weniger erprobten Techniken besteht noch viel Forschungsbedarf. Leider sind in den zitierten Studien Lagerungen, die Beschreibung der Zugänge und der Insufflationsdruck teilweise ungenau oder gar nicht beschrieben.

Diese Arbeit schafft einen Überblick über die aktuelle Studienlage der laparoskopischen Chirurgie. Darauf aufbauend können einzelne Kapitel nun genauer untersucht werden, oder vorhandene Lücken erforscht werden.

7. Appendix

7.1. List Of Figures

7.2. List Of Tables

8. References

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