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Anatomical Surgical Landmarks in Thoracolumbar Surgery of Dogs

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Table of Contents

1. List of Abbreviations

ALARA – As low as reasonably achievable

ICRP – International Commission on Radiological Protection

IVDD – Intervertebral disc disease

L – Lumbar vertebra

M. – Musculus

Mm. – Musculi

Sv – Sievert

Th – Thoracal vertebra

WSSS – Wrong-site spinal surgery

2. Introduction

In recent years, thoracolumbar surgeries have gained increasingly high importance in veterinary surgery as they can effectively treat a wide range of conditions affecting the spinal column in the thoracal and lumbar regions. Seamless anatomical knowledge is therefore essential for the surgeon to evaluate the various amount of anatomical surgical landmarks during the surgery, which can help to find the accurate site of the lesion. These landmarks are important anatomical features of the spinal structures that can be easily and safely evaluated in a reproducible manner intraoperatively. Landmarks include bony structures such as the *processi spinosi*, articular facet joints, and either *processi transversi* or costovertebral articulations, as well as muscular structures such as the insertion and position of epaxial muscles [36].

Intervertebral disc disease (IVDD) is a prevalent spinal condition in dogs, affecting approximately 2% of clinical patients. [3, 4]. Due to the unique anatomy of the *ligamentum intercapitale*, the thoracolumbar and lumbar spinal regions are more prone to IVDD. This ligament connects the head of the ribs, spanning the dorsal intervertebral space, thus preventing the prolapse of the *discus intervertebralis*, as demonstrated in **Figure 1** [15]. The ligament is rudimentary in the caudal thoracic region, which results in a higher occurrence rate of IVDD in this area [19, 37]. Over 85% of the lesions occur at the discs between the eleventh and twelfth thoracal vertebra (Th11/Th12), and second and third lumbar vertebra (L2/L3) [36, 37].

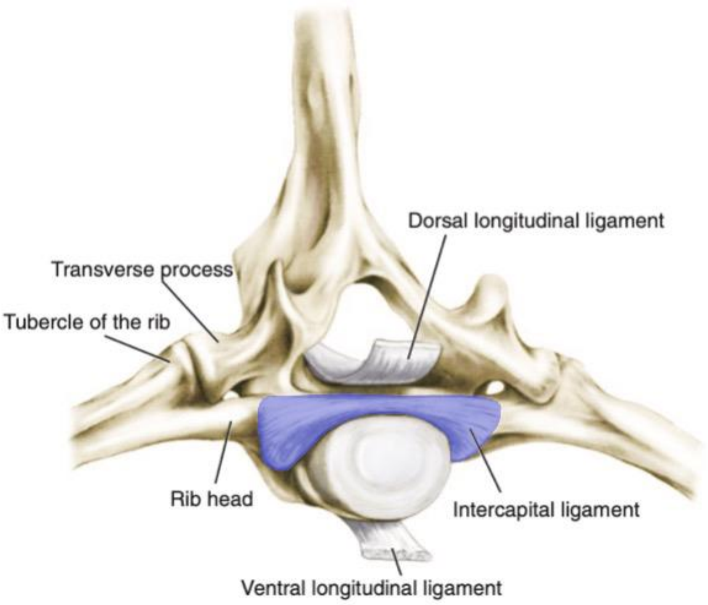

Figure 1: Canine vertebra viewed from the cranial aspect of the T1-T2 discus intervertebralis. The ligamentum intercapitale is marked in blue. [15]

Finding the correct localization of the diseased vertebra for a thoracolumbar surgery is mandatory for a successful outcome and can be ensured with various techniques. Nevertheless, studies have shown that the rate of wrong-site spinal surgeries in human medicine is between 0.03% to 5.2% [9, 22] and half of the surgeons claimed to have performed a spinal surgery at the incorrect vertebral site [22, 27]. In 1014 reviewed veterinary cases over the span of 4 years, 13 cases (1.38%) have been reported with a surgery at the wrong level [3]. The majority of wrong-site spinal surgeries have been performed at the lumbar spine (71%), followed by cervical (21%), and thoracic (8%) vertebrae [22].

A wrong-site spinal surgery (WSSS) can have several negative outcomes. An incorrect level of decompression may traumatize paraspinal soft tissues, disrupt osseoligamentous stabilizing structures, and produce epidural fibrosis [22, 27]. These consequences may increase postoperative pain and cause prolonged recovery of the patient [27]. Another major factor is the increase in anaesthesia and surgery time.

Numerous factors may contribute to the outcome of thoracolumbar surgeries, including the variables of the cardiovascular system and perfusion status of the spinal cord, as well as surgical factors such as haemorrhages or spinal cord manipulation [11]. The spinal cord's vascular autoregulation can be impaired during such surgery, leading to acute spinal cord injury. The perfusion of the spinal cord is dependent on systemic blood pressure, which could suggest that intraoperative hypotonia or bradycardia may have detrimental effects on postoperative recovery [10, 11, 21].

In human and veterinary medicine, a variety of studies have been performed with the aim of reducing the occurrence of WSSS. These recommendations include appropriate training in pre- and intraoperative image studies interpretation, thorough knowledge of surgical anatomy, and proper pre- and intraoperative identification of the accurate spine level [9, 27, 35]. For localization, several techniques can be used, such as marking the anatomical landmark by means of a sterile needle, ultrasonography, intraoperative fluoroscopy, and computed tomography [3, 25, 35].

2.1. Percutaneous palpation

Percutaneous palpation is a beneficial technique for clinical examination, as it can help locate the accurate intervertebral space for spinal surgery pre- or intraoperatively. This technique involves palpating the cranial bony landmarks of the *processus spinosus* of Th13 and the last pair of ribs and counting the *processi spinosi* caudally. Additionally, the iliac crest can be palpated to help identify the *processus spinosus* of L7, which can be used as a reference point for counting cranially to reach the affected vertebra [3, 25].

This method has an accuracy of 76.6% to 87.5% but it is suggested that percutaneous palpation far cranial from the iliac crest is more likely to be misidentified [3, 25]. In the case of obese patients, the accuracy is further decreased and shows a high error rate [3]. The benefit of this method is its cost-effectiveness and in terms of time efficiency.

In human medicine, the intercristal line, also known as Tuffier's line or Jacoby's line, is a commonly used landmark, which can be palpated, to identify the lumbar spine levels, indicating L4 and L5 interspinous space [33, 38]. Tuffier described the landmark for performing subarachnoid injections in the lumbar region [34]. However, the intercristal line was described by Jacoby as a line between the highest points of the iliac crest, passing through the vertebral body of the fourth lumbar vertebra [14].

2.2. Placement of a sterile needle and dye injection

This method is often used in clinical practice, as it is simple to perform and relatively cheap. A sterile needle is placed at the surgical site into the *processus spinosi* by percutaneous counting of the *processi spinosi* of the vertebrae [6]. The placement can be then verified by preoperative dorsolateral x-ray, fluoroscopy, or computed tomography. It is assumed that this technique has high accuracy, but could also increase the risk of surgical site contamination, but this assumption has no published evidence yet [3]. The placed needle has also a risk of displacement during the patients' transport from radiology to the surgical hall and the patients positioning preoperatively, especially in large facilities [3]. In human medicine, Nassr *et al.* [23] showed a 17,8% rate of misplaced needles in 44 out of 247 cases.

Additionally, it is also possible to mark the surgical site with a dye, typically with 0,05 to 0,1 millilitres of methylene blue. The patient is placed in lateral recumbency, and the needle is inserted into a spinous process, which is then confirmed by a lateral projection x-ray. After confirmation, the dye can be injected into the area [15].

2.3. Ultrasonography

For the accurate identification of the intervertebral space, the use of an ultrasound can be likewise beneficial. Etienne *et al.* have described the ultrasonographic anatomy of the spine, which can be used as the basis for this method. In the case of cranial interventions, the last pair of ribs may also be used [20]. Once the landmarks are found, the desired intervertebral space can be identified by counting the *processi spinosi* with the ultrasonographic image [3].

The method's accuracy can reach up to 90% but is dependent on the experience of the examiner. During the learning phase for ultrasonographical identification of the correct intervertebral space, the error rate is higher [3].

2.4. Fluoroscopy, C-arm

Besides the previously mentioned methods, intraoperative fluoroscopy is a suitable method for providing navigation during surgery and may supply valuable information on finding the correct surgical site.

In the last human consensus, it has been suggested that fluoroscopy should be the gold standard for intraoperative imaging [35]. Nevertheless, fluoroscopy might be not available in all facilities, needs skilled surgical staff and presents a risk due to radiation exposure [3, 29].

In the case of unplanned intraoperative usage of fluoroscopy, the staff must put on protective equipment, followed by mandatory rescrubbing, regowning and regloving which further increases the anaesthesia and surgical time [3].

2.5. Three-dimensional intraoperative navigation

The increasing popularity of minimally invasive thoracolumbar and lumbar surgeries demands high-quality digital imaging information about the anatomical and pathological circumstances of the patient. This may be ensured by the use of a three-dimensional intraoperative navigation system, such as the O-arm, an intraoperative computed tomography scan imaging system [32]. In comparison to fluoroscopy, the O-arm provides a multiplanar view and is able to capture typically four to five spine levels, thus improving the accuracy of pedicle screw placement [13].

With the help of the position memory function, it is possible to rapidly reposition the O-arm to ensure the taking and comparison of two consecutive images with the same angle and position [31].

For patients for whom the O-arm was used intraoperatively, the operation time was reduced in comparison to those with conventional and fluoroscopic surgery [31]. Furthermore, intraoperative use of fluoroscopy leads to a higher scatter exposure in comparison to an O-arm [1]. Therefore, the use of an O-arm may reduce the radiation exposure of the surgeon and operating room staff, if an appropriate distance from the O-arm is maintained [1, 13].

3. Aim of the study

This study is a descriptive study of nine dogs aiming to research the anatomical surgical landmarks for the thoracolumbar region between the eleventh thoracal vertebra and the first lumbar vertebra. Both bony and soft tissue landmarks will be described which can be used for orientation preoperatively and intraoperatively to possibly reduce the use of radiological devices, the amount of radiation exposure and surgical and anaesthesia time.

4. Material and Methods

4.1. Cadaver study

For this study, nine canine cadavers were used. Their age and history are unknown and had been euthanized for reasons unrelated to the present study. The cadavers were provided by the Department of Anatomy and Histology of the University of Veterinary Medicine of Budapest and handled in accordance with the university's cadaver handling regulations. The original intent of usage was for the anatomy practical dissections for the first- and second-year students.

The cadavers were grouped according to their weight into small-, medium-, and large-sized dogs, which were ranged as follows: below 10, between 10 and 25 and above 25 kilograms, respectively. Between the cadavers, there was one French Bulldog, one Shar Pai, and seven mixed-breed dogs.

4.2. Dissection

The dog cadavers were first frozen and then thawed at room temperature prior to the dissection. All nine cadavers were skinned by anatomical technicians and positioned in ventral recumbency. The position of hypodermic needles, as visible in **Figure 2**, indicates the position of the *processi spinosi* in all cases.

Firstly, the *processus spinosus* of the eleventh thoracal and the first lumbar vertebra were identified and marked with hypodermic needles, as in **Figure 2**. This was done by palpation of the last rib and thirteenth thoracal vertebra as well as identification of the sacrum and seventh lumbar vertebra, then counting the *processi spinosi* cranially. To ensure the correct localization of L7, an incision was made in the median plane at the lumbosacral region.

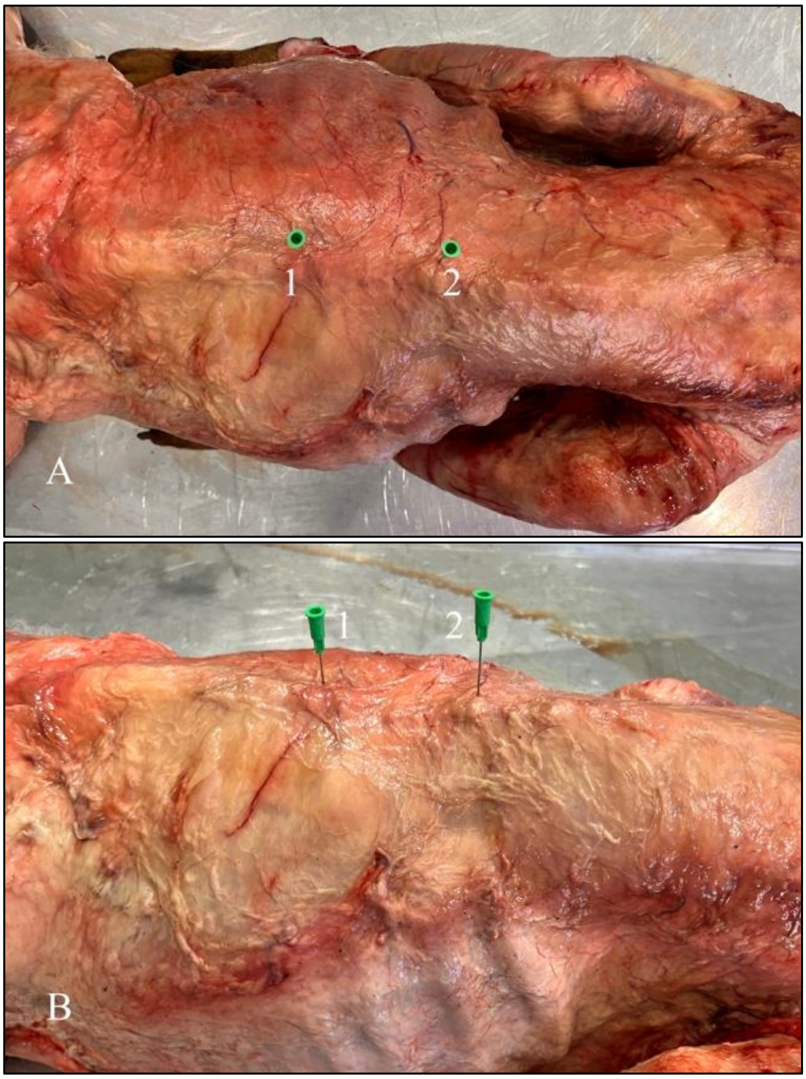

Figure 2: Placement of hypodermic needles. (A) Dorsal view on marked vertebrae Th11 (1) and L1 (2). (B) Dorsolateral view on marked vertebrae Th11 (1) and L1 (2).

The *processus spinosus* of L6 and L7 were similarly marked to assess their position to the position of the intercristal line, also called the Tuffier's line, which is drawn between the two most cranial points of the iliac crest. Forceps were placed at the most cranial palpable points of the iliac crests to indicate the intercristal line, as shown in **Figure 3**.

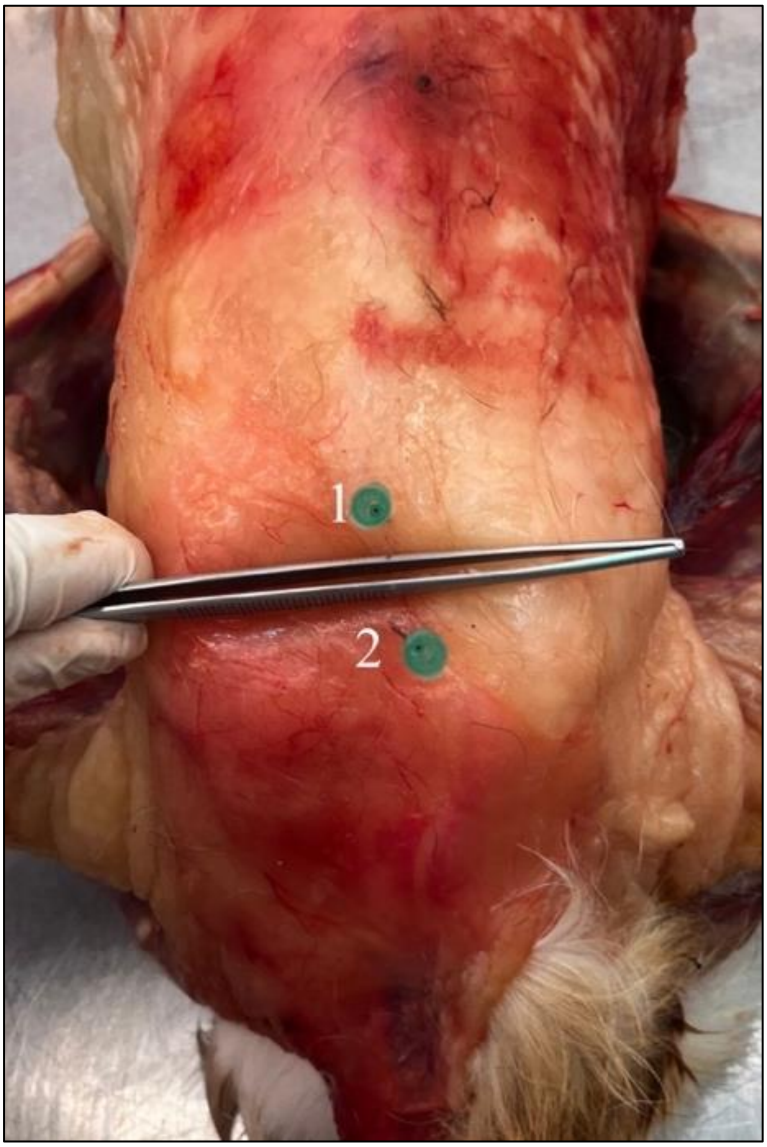

Figure 3: Dorsal view onto lumbosacral region.
Marking of L6 (1) and L7 (2).

After identifying the *fascia thoracolumbalis* under the subcutaneous fat, the fascia was incised paramedially to expose the underlying soft tissue, including the *fascia lumbodorsalis*, the *musculus (m.) spinalis et semispinalis thoracis et cervicis* and the *m. longissimus lumborum*, see in **Figure 4**.

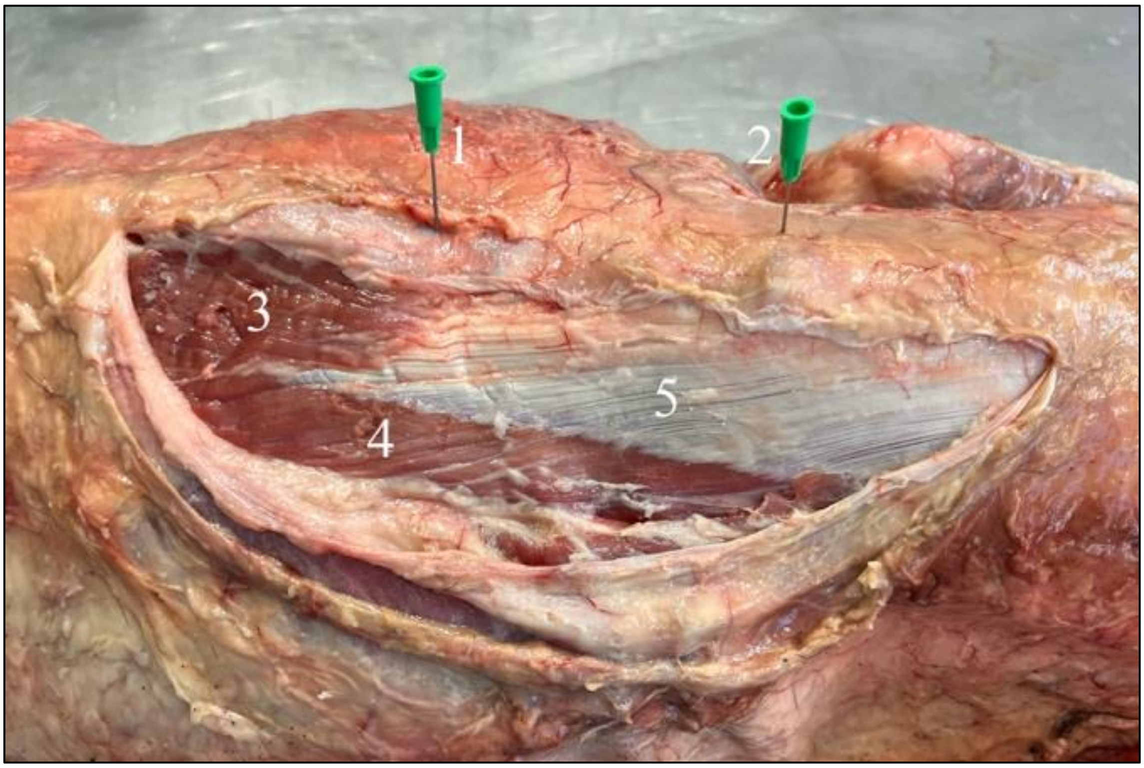

Figure 4: Dorsolateral view of soft tissue under the thoracolumbar fascia, showing Th11 (1), L1 (2), spinalis et semispinalis thoracis et cervicis muscle (3), longissimus thoracis et lumborum muscle (4) and lumbodorsal fascia (5)

Once the *fascia lumbodorsalis* was incised paramedially and opened, the *m. spinalis et semispinalis thoracis et cervicis* could be seen underneath. The muscle's tendinous insertion points at the *processi mammillares* can be then further dissected. Ventrolateral to the *musculi (mm.) multifidi* the *m. longissimus lumborum* can be identified, which inserts at the *processus accessorius* of L1.

Over the course of the dissection, the positions of the *processi mammillares*, the relation of L6 and L7 to the intercristal line, along with the insertion points of the *m. spinalis et semispinalis thoracis et cervicis*.

5. Results

5.1. Bony Landmarks

5.1.1. Vertebra anticlinalis

The *vertebra anticlinalis* is the first vertebra without a caudally slanting *processus spinosus* process. Caudally to the *vertebra anticlinalis,* the *processus spinosus* incline cranially [30].

The localization is dependent on the chosen definition. Baines *et al.* (2009) mention three definitions: P, V and J [2]. Definition P defines the *vertebra anticlinal* as the vertebra whose *processus spinosus* is perpendicular to the vertebral body, whereas in definition V the *processus spinosus* is vertical [24, 30]. The change in orientation of the intervertebral synovial joints is defined by definition J [8]. In 75% to 94.2% of dogs, the *vertebra anticlinalis* is the eleventh thoracal vertebra, seen also in **Figure 5** [2].

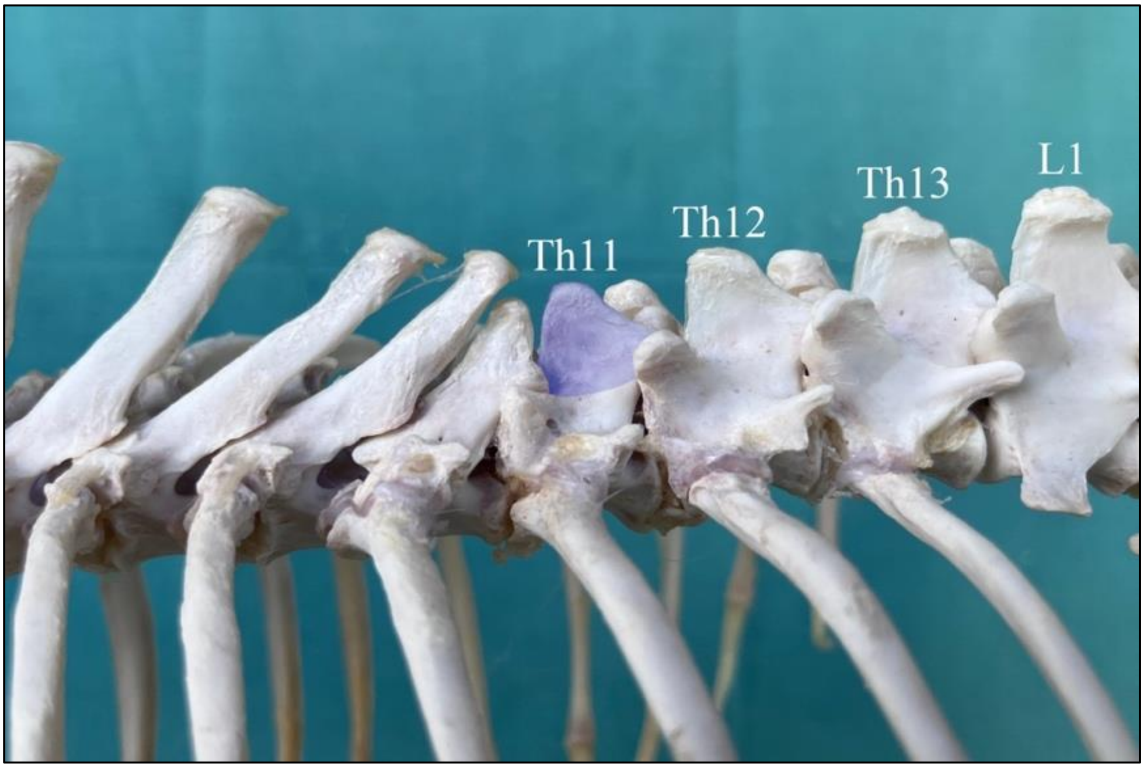

Figure 5: Lateral view of the vertebra anticlinalis of Th11, marked in blue.

5.1.2. <u>Processus mammillaris</u>

The *processus mammillaris* is superimposed on the cranial *processus articularis* of the lumbar vertebrae, also known as the *processus mammilloarticularis*. Cranial to the thoracolumbar transition the process shifts towards the cranial portion of the *processus transversus* [5]. The *processi mammillares* can be palpated at the twelfth thoracic vertebra as the most cranial point during dissection. However, the *processus mammillaris* is most prominent at Th13 and L1 and could be palpated best in all nine dissected dogs. **Figure 6** shows the position of the *processi mammillares* from the twelfth thoracal to the first lumbar vertebra.

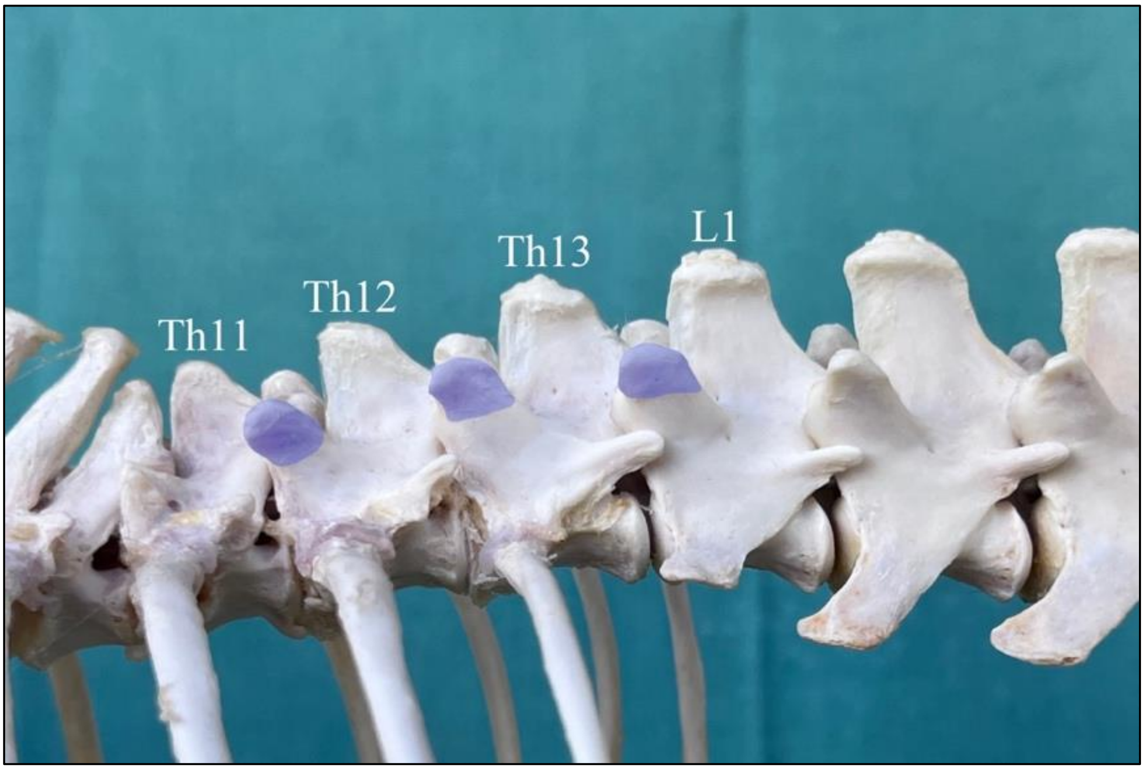

Figure 6: Dorsolateral view of the processi mammillares, marked in blue.

5.1.3. Last rib and processus transversus L1

The difference between the *processus transversus* of L1 and the last rib can be evaluated intraoperatively. In **Figure 7**, the last rib is seen slanting caudally in comparison to the relatively short *processus transversus* of L1, which inclines cranially. Intraoperatively, it should be noted that the proximal portion of the thirteenth rib is much longer than the *processus transversus* of L1. Additionally, the tip of the *processus transversus* can be palpated deeper than the last rib [36].

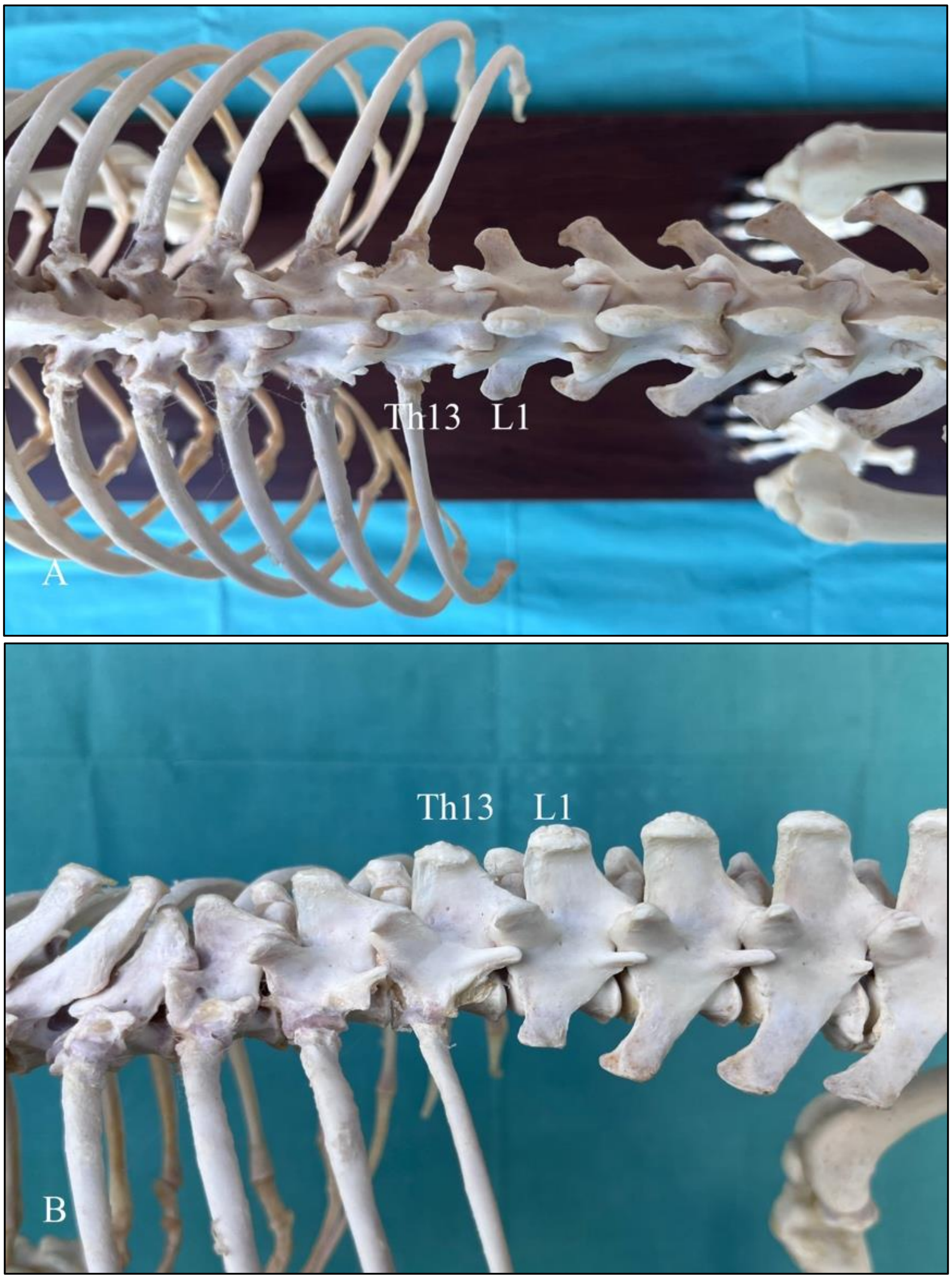

Figure 7: (A) Dorsal and (B) dorsolateral view of the thoracolumbar junction.

5.1.4. Facet joints

During the study of the skeleton as well as during the dissection, the orientation of the facet joints was assessed.

The joint between Th10 and Th11 is horizontally oriented and in a more lying position. Whereas the joint of Th11 and Th12 is the first facet joint, which is standing more dorsally with a caudo-dorsal orientation of the joint surfaces and therefore is not horizontally oriented. This is visualized in **Figure 8**, in which the joint of Th10/Th11 is marked in red and the joint of Th11/Th12 in blue.

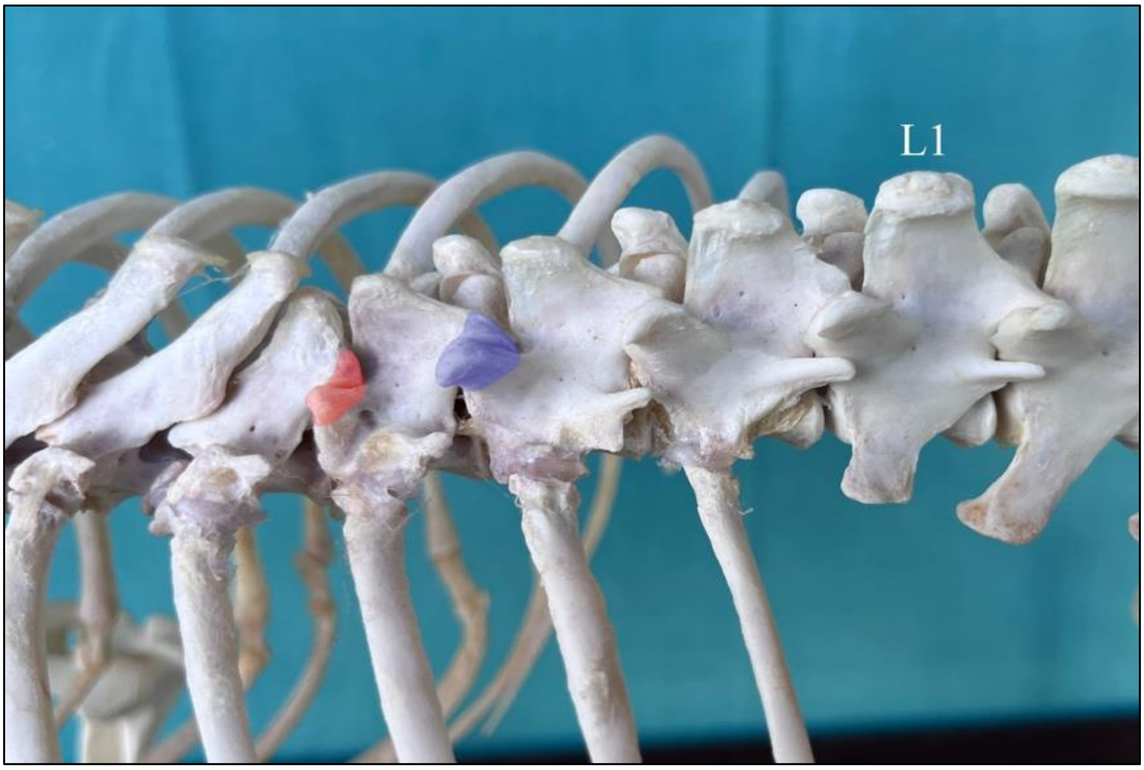

Figure 8: Dorsolateral view of the facet joints. The joint of Th10/Th11 is marked in red. The joint of Th11/Th12 is marked in blue.

5.1.5. <u>Intercristal line</u>

The dissection showed that the intercristal line passed through the interspinous space of L6 and L7 in all cadavers, as shown in **Figure 9**.

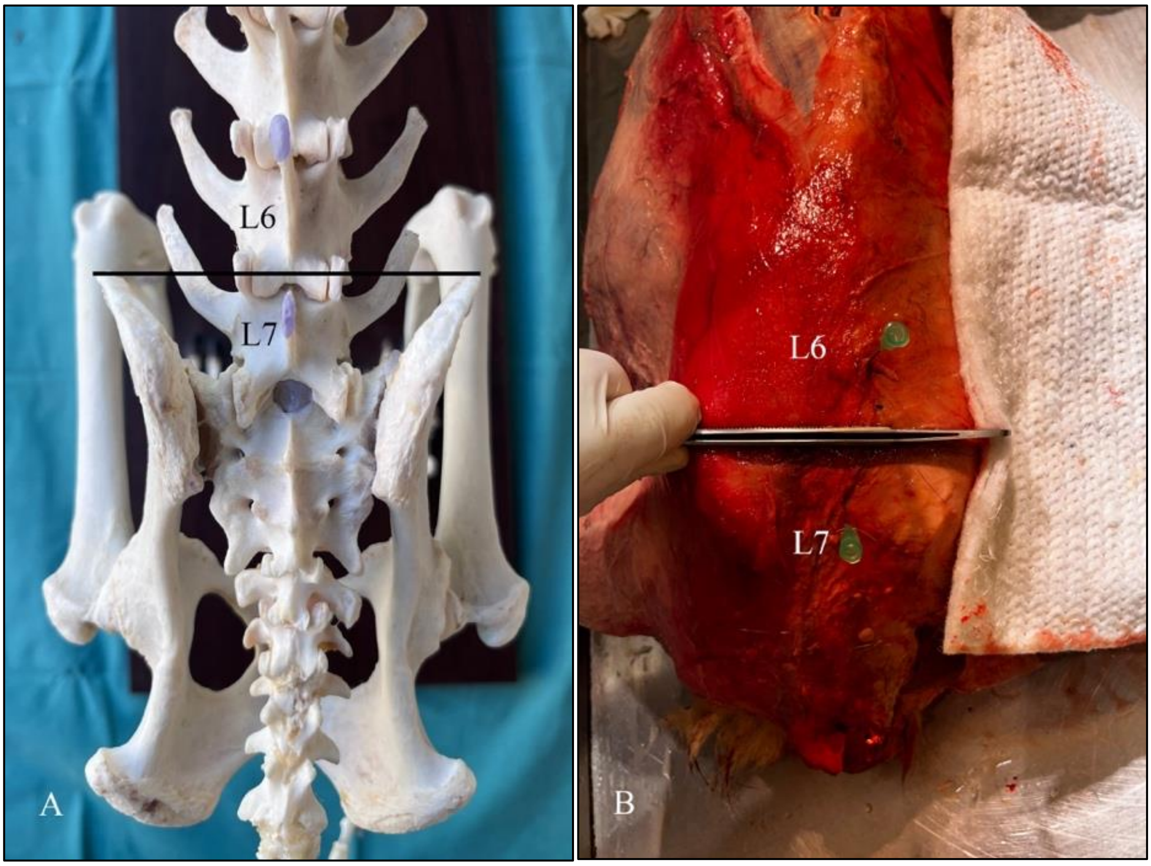

Figure 9: Dorsal view on the lumbosacral region. (A) Processi spinosi are marked in blue. The line indicates the intercristal line. (B) Processi spinosi are marked with a hypodermic needle. The forceps indicate the intercristal line.

5.2. Soft Tissue Landmarks

5.2.1. <u>M. spinalis et semispinalis thoracis et cervicis</u>

In all nine dissected cadavers, the *m. spinalis et semispinalis thoracis et cervicis* were inserted into the *fascia lumbodorsalis* at the level of Th11. The insertion is marked with arrows in **Figure 10 (A)**.

After the opening of the *fascia lumbodorsalis*, tendons originating from the *m. spinalis et semispinalis thoracis et cervicis* could be seen, which are inserted into the *processi mammillares*. **Figure 10** shows how the tendon inserting into L1 is the most dorsolateral *(A)*, whereas the tendon to Th13 lies underneath *(B)*, covering the tendon to Th12 *(C)*.

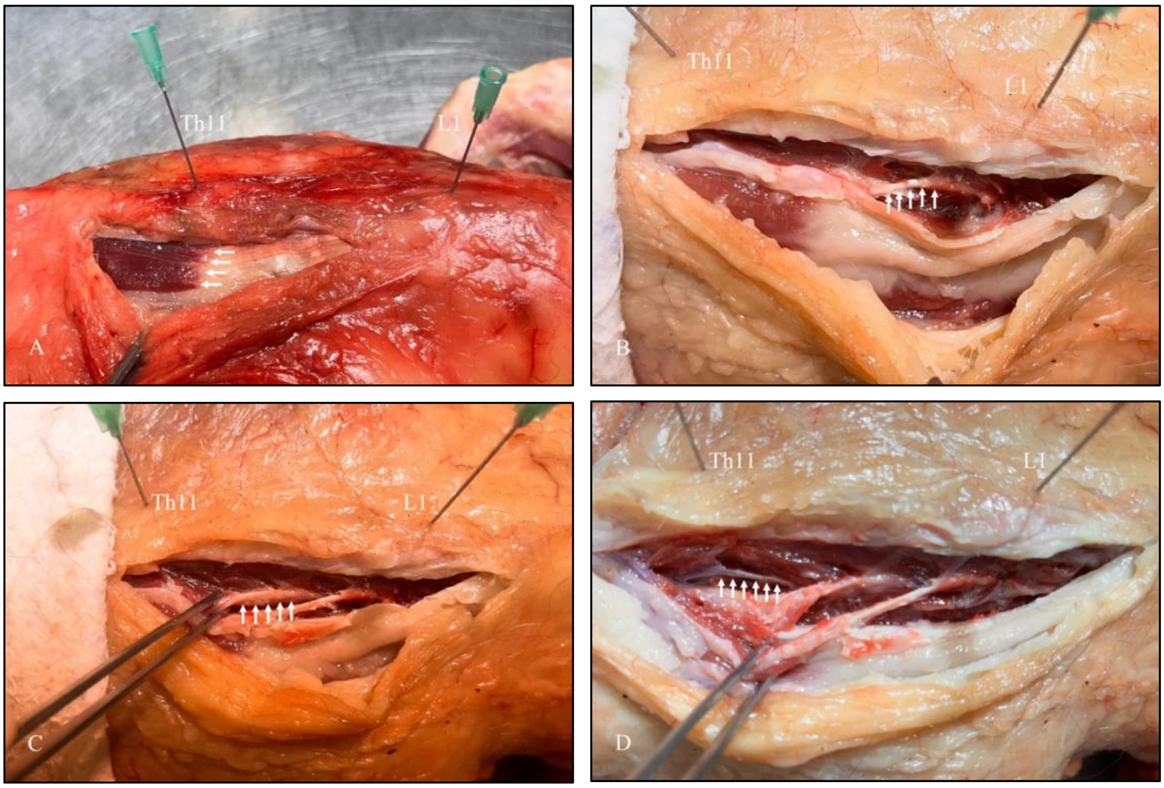

Figure 10: Dorsolateral view of the thoracolumbar region. (A) Arrows indicate the insertion of the m. spinalis et semispinalis thoracis et cervicis into the fascia lumbodorsalis.
Arrows indicate tendons inserting at the processus mammillaris of (B) L1, (C) Th13 and (D) Th12.

5.2.2. M. longissimus lumborum

The *m. longissimus lumborum* has medial tendons inserting at the *processus accessorius* of L1 to L6 [24]. During these dissections, the insertion at the *processus accessorius* of L1, marked by arrows, could be identified as shown in **Figure 11.**

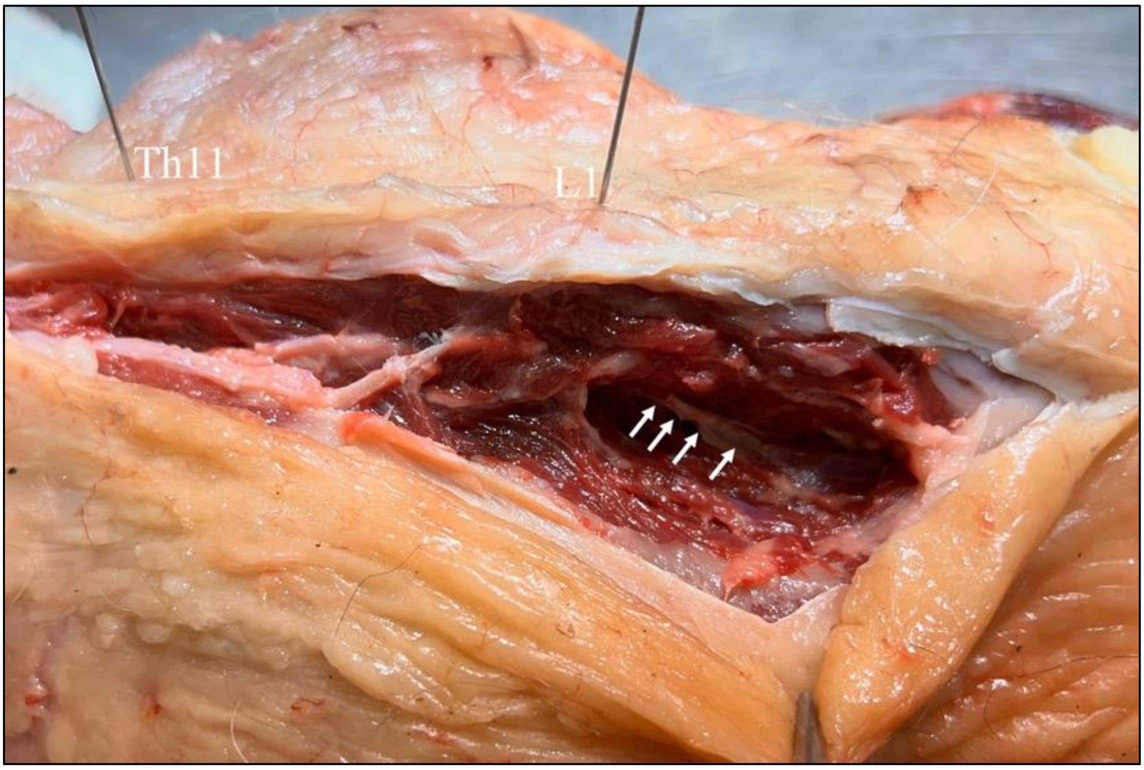

Figure 11: Dorsolateral view of the thoracolumbar region.
Arrows indicate the tendon of the m. longissimus lumborum inserted to the processus accessorius.

6. Discussion

Thorough knowledge of anatomy is essential for the successful outcome of any surgery, not only for the accurate localization of the lesion but also for intraoperative orientation. Therefore, the anatomical surgical landmarks of thoracolumbar surgery in dogs were described and dissected in this present study. To the author's knowledge, no previous reports regarding this topic have been published.

The study was limited to the thoracolumbar region from Th10 to L1. Due to the missing *lig. intercapitale*, this region represents the majority of IVDD cases [36, 37].

The dissection of the cadavers showed the consistency of important bony and soft tissue landmarks. As a bony landmark, the *processi mammillares* may be used, as they are most prominent at Th13 and L1 and can be palpated preoperatively.

The position of the *processus spinosus* of L6 and L7 may be located using the intercristal line. At the time of writing, there are no known studies about the anatomical consistency of the intercristal line in veterinary medicine. During the dissections and palpations, the intercristal line passed through the interspinous space of L6 and L7 in all dissected cadavers. For intraoperative orientation, the orientation of the facet joints can be evaluated. The joint between Th11 and Th12 is the first joint, which is not oriented horizontally and is more in a standing position than the joint between Th10 and Th11. This landmark can be used for orientation during surgeries in the region around Th11.

A soft tissue landmark which was consistent in all cadavers is the use of insertion of the *m. spinalis et semispinalis thoracis et cervicis*, it inserted into the *fascia lumbodorsalis* at the level of Th11. Additionally, individual tendons are inserted into the *processi mammillares* of the thoracolumbar vertebrae. The tendons inserted at the *processi mammillares* of L1 are the most dorsolateral laying, covering the tendon which inserts to Th13.

The importance of wrong-site spinal surgery in veterinary medicine has not yet been fundamentally studied. In human medicine, the rate of WSSS varies between 0.03% and 5.2%, whereas in veterinary medicine one study showed a rate of 1.28% [3, 9, 22].

There are several factors which may contribute to an incorrect surgical site. The physician may misinterpret the radiographs preoperatively or intraoperatively [27]. Skin markers, like the placement of a sterile needle at the surgical site, could be misplaced during the transport or positioning of the patient in the surgical hall [3, 27]. Chondrodystrophic dogs show a higher rate of anatomical anomalies, such as long backs, miniaturisation and obesity, increasing the risk of developing IVDD during normal activity, such as climbing stairs and jumping [18, 26]. Anatomical variations in the thoracolumbar spine regions and decreased accuracy of percutaneous palpations in obese patients might contribute to the increased risk of WSSS [3].

The consequences of WSSS range from traumatized paraspinal soft tissues to disrupted osseoligamentous structures and epidural fibrosis, as well as increased postoperative recovery time [22, 27]. Besides structural damage, there is an increase in anaesthesia and surgery time and possibly an increase in the use of intraoperative radiological devices, such as fluoroscopy or three-dimensional intraoperative navigation O-arm. Unintended use of intraoperative radiological devices will lead to rescrubbing, regowning and regloving as the staff has to put on protective equipment, which additionally increases the anaesthesia time [3].

Commonly described anatomically important landmarks for the orientation in the thoracolumbar region include the *vertebra anticlinalis*, which is in 75% to 94.2% at the eleventh vertebra [2]. The vertebra can be identified during preoperative radiological examination and used for orientation during the surgery.

For the preoperative identification of the *processus spinosus* of Th13, the use of palpation of the last rib is very beneficial. Standing on the left of the dog, the tips of the thumb and middle finger of the right hand are placed at the caudal aspect of the left and right thirteenth rib. With slight flexion of the wrist, the index finger has contact with a spinous process, which is Th13. This can be confirmed by palpating the next caudal *processus spinosus*, which should be L1, and thus be wider than Th13 [25].

During the dorsolateral approach of the thoracolumbar region, the last rib may be differentiated intraoperatively by palpation from the transverse process of L1. The cranially slanting *processus transversus* is much shorter than the caudally slanting thirteenth rib. The insertion of the *m. spinalis et semispinalis thoracis et cervicis* at Th11 may be evaluated after incising the *fascia thoracolumbalis*. Our study adds less known or considered consistent landmarks that can be easily used intraoperatively for safe anatomical orientation.

The present study also aims to reduce the intraoperative use of radiological devices by improving the knowledge of thoracolumbar anatomy and its landmarks. The pathological effects due to radiation exposure were reviewed by several authors. One major concern is the increased risk of cancer, whereas a cumulative amount of 1 Sievert (Sv) of radiation exposure increases the individual risk of developing solid cancer by 60%. The same amount of radiation exposure also increases the absolute risk of cancer mortality by 5% [12, 16]. In human medicine, Chou *et al.* [7] surveyed many female orthopaedic, urologic and plastic surgeons about the history of cancer, the use of fluoroscopy and the medical history. The most frequent use of fluoroscopy was the greatest in orthopaedic surgeons, followed by urology and plastic surgeons. The total amount of cancer under the orthopaedic surgeons had significantly higher prevalence than the expected value, whereas the urology and plastic surgeons did not show significant differences in comparison to US citizens. Additionally, a 2.9-fold increase in the risk of breast cancer was observed in the case of orthopaedic surgeons [7].

To reduce the radiation exposure of surgical staff and patients, the use of the concept of “as low as reasonably achievable (ALARA)” can be recommended [28]. The International Commission on Radiological Protection (ICRP) recommended that occupational radiologic exposure should not exceed an annual average of 20 mSv over 5 years, with not a single year above 50 mSv [16]. Maintaining an appropriate distance from the device and the use of personal protective equipment by the staff, such as lead aprons, lead glasses and thyroid protectives can ensure that the amount of radiation exposure can be kept as low as reasonably achievable [17].

One limitation of this descriptive study is the small sample size of nine dogs, which were kindly provided by the Department of Anatomy and Histology at the University of Veterinary Medicine, Budapest. Due to the deskinning of the cadavers prior to dissection, any palpation findings may have been altered.

The study did not consider possible anatomical anomalies as well as possible differences due to the size of the animals and breed-specific anatomical variations. Additionally, the different sexes of the dissected dogs were not considered in this study.

As the study of the intercristal line was only made by palpation and has a low sample number, it needs further radiographical studies for its proper assessment with a larger sample size. The initial dissections showed that the Tuffier's line indicates the intraspinal space between the sixth and seventh lumbar vertebrae. In one of the dissected dogs, the seventh lumbar vertebra was not percutaneously palpable, suggesting that the position of the intercristal line should be assessed by preoperative radiography.

For the correct identification of the surgical site, it is advisable to use and combine multiple techniques, such as using a percutaneous guidance needle placement and percutaneous palpation prior to the surgery and incision. Intraoperatively, the anatomical landmarks should be carefully evaluated to ensure the proper localization of the surgery [36]. Those bony landmarks include the spinous process of the anticlinal vertebra, the difference between the transverse process of L1 and the last rib and the relationship of L6 to the wings of the ilium [25, 36]. The use of the *processi mammillares* could likewise provide valuable information as they are most accessible at Th13 and L1. For surgeries around Th11, it is advisable to assess the orientation of the facet joint.

Soft tissue landmarks, which have been consistent throughout all dissected dogs include the insertion of the spinalis and semispinalis muscle into the *fascia lumbodorsalis* at Th11. Additionally, the evaluation of the position of the inserting tendons could be used as well as the insertion of the *m. longissimus lumborum* into the *processus accessorius* of L1.

Considering this information, anatomical surgical landmarks should be evaluated preoperatively as well as intraoperatively to reduce the risk of a WSSS and potentially reduce the surgical and anaesthesia time. The use of digital imaging is strongly advisable and may be used for more accurate localization and to determine possible surgically relevant anatomical anomalies. Proper preoperative preparation for the surgery should be done before surgery to avoid wrong-site surgeries and associated problems.

7. Abstract

7.1. English Abstract

In recent years, thoracolumbar surgeries have gained increasingly high importance in veterinary surgery as they can effectively treat a wide range of conditions affecting the spinal column in the thoracal and lumbar regions. Seamless anatomical knowledge is therefore essential for the surgeon to evaluate the various amount of anatomical surgical landmarks during the surgery, which can help to find the accurate site of the lesion. These landmarks are important anatomical features of the spinal structures that can be easily and safely evaluated in a reproducible manner intraoperatively.

In human and veterinary medicine, various studies have been performed to reduce the occurrence of wrong-site spinal surgery. A surgery at an incorrect level may have several negative outcomes for the patient and may increase the surgical time.

This descriptive study of nine dog cadavers aims to research the anatomical surgical landmarks for the thoracolumbar region between the eleventh thoracal vertebra and the first lumbar vertebra. Both bony and soft tissue landmarks are described which can be used for orientation preoperatively and intraoperatively to possibly reduce the use of radiological devices, the amount of radiation exposure and surgical and anaesthesia time.

The cadavers were dissected in ventral recumbency at the thoracolumbar region. Over the course of the dissection, the landmarks were dissected including the assessment of the positions of the *processi mammillares*, the relation of L6 and L7 to the intercristal line, along with the insertion points of the *musculus spinalis et semispinalis thoracis et cervicis*.

The dissection showed the consistency of various landmarks. The bony landmarks include the *processus spinosus* of the anticlinal vertebra, the difference between the *processus transversus* of L1 and the last rib and the intercristal line, which passes through the interspinous space of L6 and L7. The use of the *processi mammillares* could likewise provide valuable information as they are most accessible at Th13 and L1. For surgeries around Th11, it is advisable to assess the orientation of the facet joint. Soft tissue landmarks, which have been consistent throughout all nine dogs include the insertion of the *musculus spinalis et semispinalis thoracis et cervicis* into the *fascia lumbodorsalis* at Th11. Additionally, the evaluation of the position of the inserting tendons could be used as well as the insertion of the *musculus longissimus lumborum* into the accessory process of L1.

Anatomical surgical landmarks should be evaluated preoperatively as well as intraoperatively to reduce the risk of wrong-site spinal surgery and potentially reduce surgical time. Proper preoperative preparation for the surgery should be done before surgery to avoid wrong-site surgeries and associated problems.

7.2. Hungarian Abstract

Az utóbbi években a thoracolumbalis régiót érintő műtétek egyre nagyobb fontossággal bírnak az állatorvosi sebészetben, mivel ezen technikákkal számos mellkasi és ágyéki gerincet érintő kórkép hatékonyan kezelhetővé válhat. A részletes anatómiai tudás elengedhetetlen a sebész számára, hogy értelmezni tudja az anatómiai sebészeti támpontokat az operáció során, amelyek segítenek megtalálni az elváltozás pontos helyét. Ezen támpontok különböző anatómiai képletek a gerincoszlop mentén, melyek könnyen és biztonsággal felismerhetők reprodukálható módon a beavatkozás alatt.

Az ember- és állatorvoslásban számos különböző tanulmányt végeztek annak érdekében, hogy csökkentsék a helytelen irányból megközelített gerincműtétek számát. A pontatlan helyről megközelített műtéteknek számos negatív következménye lehet a páciens számára, egyúttal növelheti az operáció idejét.

E kilenc tetemmel végzett kutatás célja, hogy feltárja a thoracolumbalis régió anatómiai és sebészeti támpontjait a tizenegyedik háti- és első ágyéki csigolya közötti szakaszon. Mind a csontos, illetve lágyszöveti képletek leírásra kerültek, melyek segítenek a tájékozódásban preoperatívan és intraoperatívan egyaránt, hogy csökkentsük a radiológiai eszközök használatát, így a sugárzásnak való kitettség mértékét, továbbá a műtét és az altatás idejét.

A tetemek thoracolumbalis régióját hasi fektetésben boncoltuk. A boncolás során a támpontot adó képleteket értékeltük, beleérve a *processus mamillaris*-ok pozícióját, az L6 és L7 csigolya viszonyát a *linea intercristalis*-hoz a *m. spinalis et semispinalis thoracis et cervicis* tapadási pontjaival együtt.

A boncolással különböző csontos és lágyszöveti tájékozódási pontok konzisztensen felkereshetőek voltak. A csontos struktúrák, köztük a *vertebra anticlinaris* tövisnyúlványa, a különbség az L1 harántnyúlványa, az utolsó borda és a *linea intercristalis* között, amely az L6 és L7 csigolyák közötti részben halad. A *processus mamillaris*-ok használata szintén értékes információval szolgálhat, mivel ezek a Th13 és L1 csigolyánál a legkönnyebben hozzáférhetők. A Th11-et érintő műtétek esetén javasolt a facet ízület orientációját is értékelni. A lágyszöveti képleteket, melyek egyaránt jelen voltak mind a kilenc kutyában, beleértve a *m.* spinalis et semispinalis *thoracis et cervicis* tapadási pontját a *fascia lumbodorsalis*-on a Th11 magasságában. Továbbá a tapadási ínak pozíciójának értékelése és a lumbalis izmok tapadási pontja az L1 járulákos nyúlványához szintén használható.

Az anatómiai és sebészeti támpontok értékelése preoperatívan és intraoperatívan is fontos, mert ezzel csökkenthető a pontatlan helyen történő műtéti feltárás és potenciálisan csökkenthető az ebből adódó hosszabb műtéti idő. A megfelelő preoperatív előkészületek elvégzése minden esetben fontos, hogy elkerülhessük a nem megfelelő helyről végzett műtétekkel járó komplikációkat.

8. List of Figures

9. References

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