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The Impact of Patient-Specific Positions on the Relationship between Iliac Blood Vessels and Lumbar Intervertebral Discs: Anatomical Significance and Clinical Implications

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Abstract: This study explores the anatomical relationship between iliac blood vessels and the lower lumbar spine during supine and prone patient positions. The average height of participants was 174.02 cm ± 9.01, while the average weight was 80.38 kg ± 13.48. Body mass index (BMI) analyses showed differences ($p = 0.002$), with 34.7% classified as normal weight, 53.1% as overweight, and 12.2% as moderately obese. The study examined the distances between iliac arteries and veins in relation to intervertebral anterior and posterior disc contours. Patient positioning significantly affected these measurements at both L4/L5 and L5/S1 levels. The findings highlight the critical influence of body position on anatomical relationships in the context of lower lumbar spine surgery. The study underscores the importance of preoperative awareness of vascular anatomy to prevent iatrogenic lesions during spine surgery, contributing valuable insights for optimizing surgical approaches and minimizing complications in spine surgery, particularly microdiscectomy.

Keywords: spine; anatomy; iliac blood vessels; disc herniation; retroperitoneal blood vessels; clinical anatomy

1. Introduction

Understanding the precise anatomical relationship between the large retroperitoneal blood vessels and lumbar spine structures is paramount for comprehending both normal anatomy and pathological processes within the retroperitoneum and lumbar spine [1]. This knowledge is particularly in regard to surgical planning, regardless of whether employing a front or posterior approach [2]. Historically, anatomical studies in this domain were confined to cadaveric research, providing a foundational understanding of the region's anatomy, with a focus on large blood vessels. However, this approach had limitations in accounting for potential in vivo anatomical variations. The advent of modern diagnostic tools, particularly computed tomography (CT) and magnetic resonance imaging (MRI), paved the way for in vivo research [3]. Subsequently, several morphometric studies have been conducted which primarily explored anatomical variations and relationships between retroperitoneal structures and the height of major blood vessel bifurcations [4]. The surge in interest for detailed investigations of large retroperitoneal blood vessels stems from the proliferation of surgical techniques employed in the lumbar spine and retroperitoneal interventions. This surge is coupled with a heightened awareness of complications arising from iatrogenic damage to critical retroperitoneal structures [5].

The spinal column encompasses 33 or 34 vertebrae, extending from the occipital bone to the pelvis, with the lumbar segment crucial for weight-bearing and distributing loads to the lower extremities [1,6]. This segment, composed of five robust vertebrae interconnected by discs and ligaments, is clinically divided into upper (L1–L3) and lower (L4–L5) segments, with the latter enduring greater loads and degenerative disc disease. Lumbar vertebrae, among the largest and sturdiest, play a pivotal role in supporting the body's weight [1,7]. They possess distinct features (such as the vertebral body, laminae, processes, and facets) contributing to their load-bearing capacity [8,9]. The intervertebral disc, positioned between adjacent vertebrae, is vital for load distribution and compression resistance. Comprising the nucleus pulposus, anulus fibrosus, and hyaline cartilage end plates, its structure influences its function and susceptibility to degenerative changes [10]. Common iliac arteries, originating at the fourth lumbar vertebra, divide into internal and external branches, exhibiting variability in bifurcation levels [11]. Their intimate association with lumbar spine structures underscores their clinical significance, particularly in surgical contexts. The common iliac vein, responsible for draining blood from the pelvis and lower extremities, shows variability in its relationships with adjacent structures, emphasizing the importance of understanding these variations for surgical planning and intervention.

This research aims to provide a comprehensive analysis of the anatomical intricacies of iliac blood vessels in relation to lumbar intervertebral discs, shedding light on the clinical implications for surgical interventions in this region.

2. Materials and Methods

2.1. Study Design and Participants

The study is prospective and non-randomized, involving 60 participants of various genders and ages. Each participant provided informed consent prior to participating in the study after receiving detailed information about the research. The research was conducted with the approval of the Ethical Committee of the Cantonal Hospital Zenica.

The inclusion criteria for this study were as follows: (1) participants aged 18 years or older, (2) participants who provided informed consent following detailed information about the research, and (3) individuals with a diagnosis of chronic low back pain. Exclusion criteria for the study encompassed: (1) patients with a history of abdominal or pelvic surgeries, (2) any surgeries involving the lumbar spine and retroperitoneum, (3) patients with confirmed inflammatory and expansive lesions in the retroperitoneum, (4) aortic aneurysms and their terminal branches, (5) expansive lesions of the vertebrae, (6) massive disc herniations, (7) spondylolisthesis, (8) scoliosis, (9) lumbar kyphosis, and (10) other vertebral and spinal anomalies.

2.2. Methods

Following consent and the signing of the informed consent form, all patients had their height–weight measured and their BMI (Body Mass Index) calculated. Patients were classified based on BMI as follows: severely underweight ($\leq$16 kg/m^2), underweight (16.0–18.4 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), moderately obese (30.0–34.9 kg/m^2), severely obese (35.0–39.9 kg/m^2), and morbidly obese ($\geq$40.0 kg/m^2) [12]. All participants who were included in the study and provided informed consent underwent magnetic resonance imaging (MRI) of the lumbosacral spine using the standard study protocol (Siemens Magnetom Avanto 1.5 T, Erlangen, Germany).

This protocol included T1 and T2 sequences in the axial, sagittal, and coronal planes. After the standard MRI protocol was completed, patients were placed in the prone position and an additional MRI was performed. This prone position MRI also included T1 and T2 sequences in the axial, sagittal, and coronal planes. To mitigate artifacts caused by respiratory movements of the chest, special pads were placed under the chest and hips of each patient. This practice is typically employed during prone position imaging in surgical procedures. The positioning of each individual patient in the machine, both in supine and prone positions, was conducted by the researcher themselves.

Following the acquisition of MRI scans in both supine and prone positions, all images were transferred to the IMPAX system (Agfa Healthcare Impax 6.5.3.2525). This system enables direct analysis and measurement of anatomical structures in all planes. The analysis of each image was conducted by the researcher under the supervision of a specialized radiologist.

The study focused solely on the relationship of the lower segment of the lumbosacral spine (L4/L5 and L5/S1), specifically the anterior and posterior contours of the intervertebral disc at these levels, as well as the common iliac artery and common iliac vein on both the right and left sides. The study involved a comprehensive analysis of various morphometric parameters, including the ratio of the anterior contour of the fibrous ring to the posterior wall of the common iliac arteries, the diameter of the posterior edge of the fibrous ring to the iliac arteries and veins, and the ratio of the anterior edge of the fibrous ring to the posterior wall of the common iliac veins (Figure 1). Additionally, the study investigated alterations in the position and orientation of blood vessels in relation to the structures of the lower spinal segments, considering changes in body position (supine and prone) as well as factors such as height, weight, and BMI.

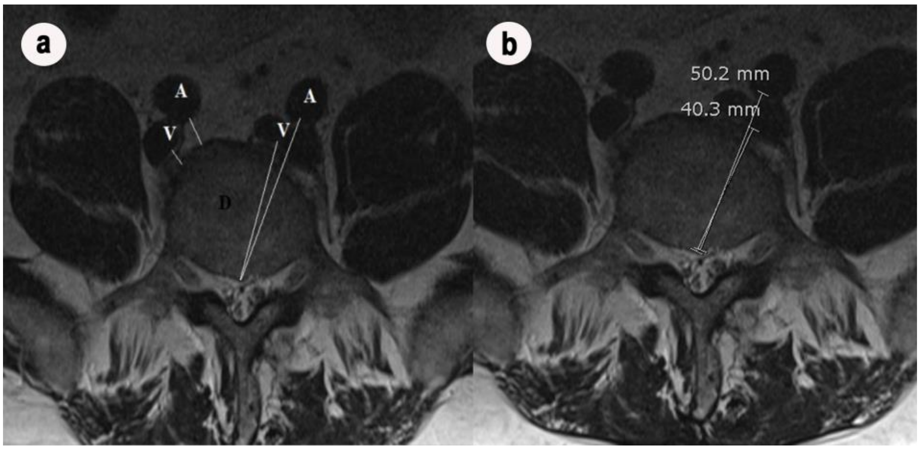

Figure 1. Display of measured parameters in figure (**a**), where the distance between the common iliac arteries (A) and veins (V) in relation to the observed part of the disc (anterior and posterior contour) can be observed. Figure (**b**) represents the measurements taken from the posterior contour of the disc to the common iliac artery and vein on the left side. D—disc (intervertebral).

Measurements were conducted on the distances between the right and left common iliac arteries at the L4/L5 intervertebral level in both prone and supine positions (Figure 2a) as well as the common iliac veins (Figure 2b).

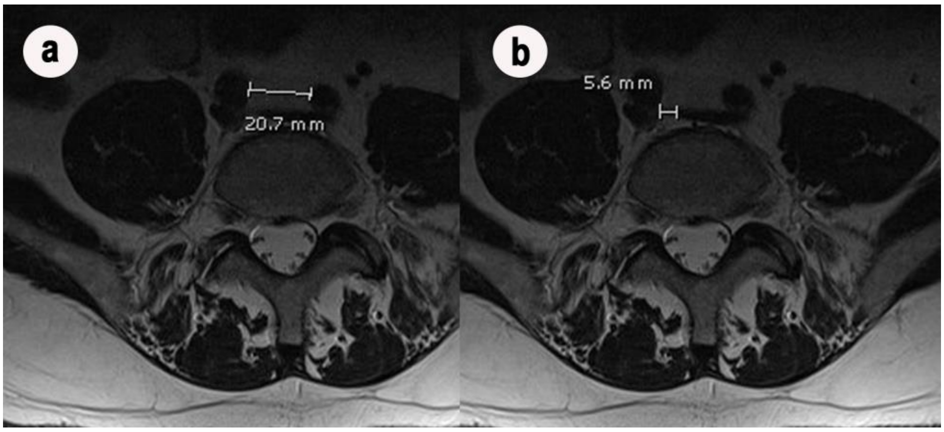

Figure 2. Depiction of measured parameters, focusing on the observed distances between common iliac arteries (**a**) and veins (**b**).

In addition to the mentioned measurements, displacement of the common iliac vein and artery was also measured in both prone and supine positions. This was accomplished by drawing a vertical line in the described software on the midsagittal section, then subsequently measuring the distance from the medial contour of the blood vessel to the artificial line, as illustrated in Figure 3.

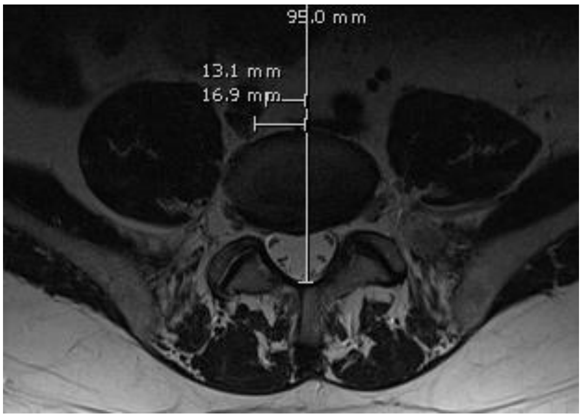

Figure 3. Movement of the iliac blood vessels at the L4/L5 intervertebral disc level relative to the midsagittal plane.

2.3. Statistical Analysis

The statistical analysis was conducted using the SPSS software (ver. 27.0., Statistical Package for the Social Sciences, IBM Inc., Armonk, NY, USA). Data were presented in the form of means (M) and standard deviations (SD). For normally distributed parameters, the *t*-student's test was employed, while non-parametric tests, such as the chi-square test for categorical variables and the Wilcoxon test for continuous variables, were used for deviations from normal distribution. The Wilcoxon rank-sum test was utilized to compare values with respect to position, while the ANOVA test was employed for normally distributed variables. Statistical significance was set at $\leq$0.05.

3. Results

The average height of the patients is 174.02 cm, with a standard deviation of 9.01. Heights range from 155.0 to 194.0 cm ($p = 0.282$), indicating that there are no statistically significant differences in height among the patients. The average weight of the patients is 80.38 kg, with a standard deviation of 13.48. Weights range from 57.0 to 118.0 kg ($p = 0.430$), suggesting that there are no statistically significant differences in weight among the patients. However, when considering BMI, an interesting observation emerges. The average BMI is 26.53 kg/m^2, with a standard deviation of 3.20 ($p = 0.002$) (Table 1). In this patient population, there were 17 individuals (34.7%) with a normal weight, 26 individuals (53.1%) who were overweight, and six individuals (12.2%) classified as moderately obese based on their BMI frequencies (Figure 4).

Table 1. Baseline characteristics of participants.

Variable		No (%) or M ± SD (Min–Max)	*p*
Sex	Male	27 (45%)	0.439
	Female	33 (55%)	
Age (years)		56.07 ± 10.43 (30.0–73.0)	0.921
Height (cm)		174.02 ± 9.01 (155.0–194.0)	0.282
Weight (kg)		80.38 ± 13.48 (57.0–118.0)	0.430
BMI (kg/m^2)		26.53 ± 3.20 (19.3–31.7)	0.002

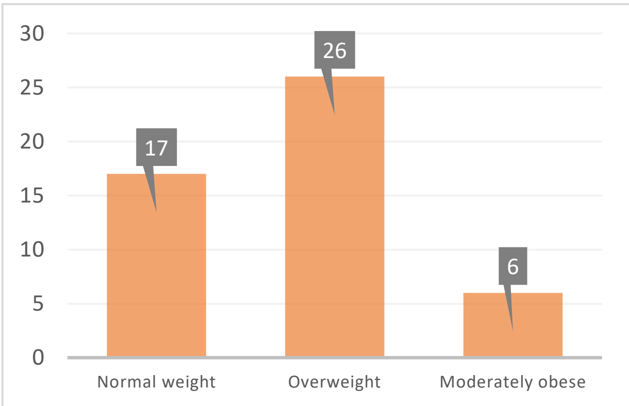

Figure 4. The distribution of patients based on BMI categories.

In the supine position at the L4/L5 level, RIA (A) had a mean measurement of 5.08 ± 3.60 mm (range: 0.5–15.5), whereas, in the prone position, it measured 6.75 ± 4.19 (range: 1.3–22.0), with a highly significant difference ($p < 0.001$). Similarly, LIA (A) showed significant differences with a mean measurement of 2.72 ± 2.56 mm (range: 0.6–14.1) in the supine position and 4.23 ± 2.70 mm (range: 1.3–15.9) in the prone position at the L4/L5 level ($p < 0.001$).

This trend continued with RIV (A) and LVI (A), emphasizing the critical impact of patient positioning on these measurements in the context of the L4/L5 level. Turning to the posterior contours of intervertebral discs at the L4/L5 level, we observed analogous significant differences between the supine and prone positions. Right and left common iliac arteries (RIA and LIA) both displayed notable variances, as did the right and left common iliac veins (RIV and LVI). For instance, the mean measurement of RIA (P) at the L4/L5 level was 47.18 ± 6.47 mm (range: 36.3–62.8) in the supine position and 49.24 ± 6.73 mm (range: 39.1–70.2) in the prone position, with a highly significant difference ($p < 0.001$) (Figure 5).

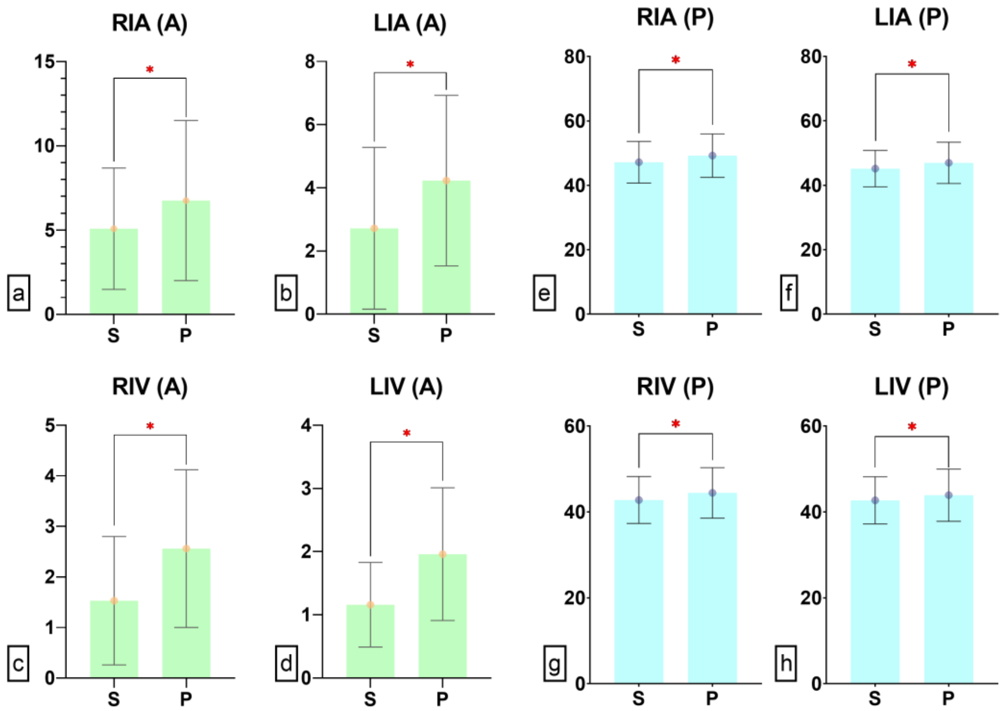

Figure 5. Differences in supine and prone positions of patients concerning the anterior (green) and posterior (blue) contours of the intervertebral disc and iliac blood vessels at the L4/L5 level: (**a**) Differences in the distance of the right common iliac artery (RIA) from the anterior contour of the disc in supine (S) and prone (P) positions; (**b**) Differences in the distance of the left common iliac artery (LIA) from the anterior contour of the disc in supine S and P positions; (**c**) Differences in the distance of the right common iliac artery (RIV) from the anterior contour of the disc in S and P positions; (**d**) Differences in the distance of the left common iliac artery (LIV) from the anterior contour of the disc in S and P positions; (**e**) Variations in the distance of the RIA from the posterior contour of the disc in S and P positions; (**f**) Differences in the distance of the LIA from the posterior contour of the disc in S and P positions; (**g**) Discrepancies in the distance of the RIV from the posterior contour of the disc in S and P positions; (**h**) Differences in the distance of the LIV from the posterior contour of the disc in S and P positions; *, statistically significant differences ($p \leq 0.001$).

For the anterior contours of intervertebral discs (A) at the L5/S1 level, encompassing RIA, LIA, RIV, and LVI, the findings underscored substantial variations between the two positions. In the supine position, RIA (A) displayed a mean measurement of 5.64 ± 3.10 (range: 0.6–13.9), while in the prone position it measured 7.77 ± 3.62 mm (range: 1.3–17.3), revealing a highly significant difference ($p < 0.001$). Similarly, LIA (A) exhibited noteworthy differences, with a mean measurement of 9.74 ± 3.97 mm (range: 1.3–18.9) in the supine position and 11.69 ± 4.05 mm (range: 1.7–22.2) in the prone position, again demonstrating a highly significant difference ($p < 0.001$).

When it comes to posterior contours of intervertebral discs (P) at the L5/S1 level, the study unveiled analogous significant differences between the supine and prone positions. Both right and left common iliac arteries (RIA and LIA) exhibited remarkable variances, as did the right and left common iliac veins (RIV and LVI). For instance, the mean measurement of RIA (P) at the L5/S1 level was 45.20 ± 5.59 mm (range: 35.1–57.6) in the supine position and 47.71 ± 6.19 mm (range: 35.4–59.2) in the prone position, signifying a highly significant difference ($p < 0.001$) (Figure 6).

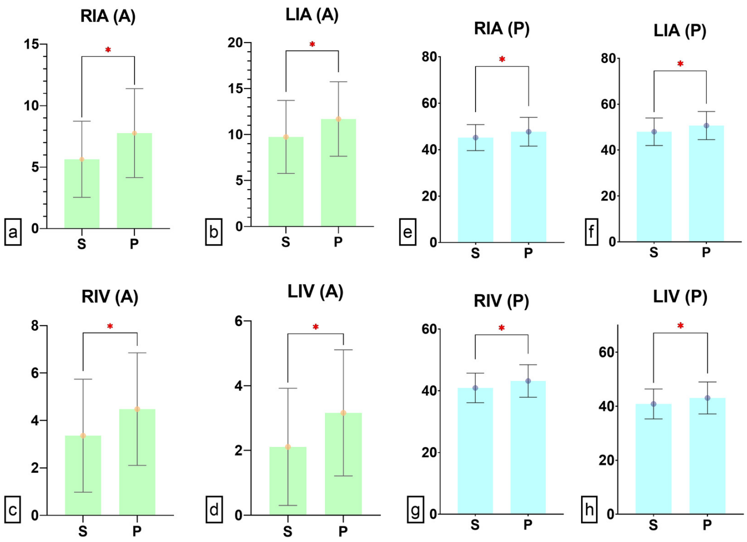

Figure 6. Differences in supine and prone positions of patients in relation of anterior (green) and posterior (blue) contour of intervertebral disc and iliac blood vessels on L5/S1 level: (**a**) Differences in the distance of the right common iliac artery (RIA) from the anterior contour of the disc in supine (S) and prone (P) positions; (**b**) Differences in the distance of the left common iliac artery (LIA) from the anterior contour of the disc in supine S and P positions; (**c**) Differences in the distance of the right common iliac artery (RIV) from the anterior contour of the disc in S and P positions; (**d**) Differences in the distance of the left common iliac artery (LIV) from the anterior contour of the disc in S and P positions; (**e**) Variations in the distance of the RIA from the posterior contour of the disc in S and P positions; (**f**) Differences in the distance of the LIA from the posterior contour of the disc in S and P positions; (**g**) Discrepancies in the distance of the RIV from the posterior contour of the disc in S and P positions; (**h**) Differences in the distance of the LIV from the posterior contour of the disc in S and P positions; *, statistically significant differences ($p \leq 0.001$).

Data provided in Figure 3 data reveal insights into the positional variations of iliac blood vessels at the L5/S1 level in both supine and prone positions. When it comes to RIA, there is a noticeable increase from 17.51 ± 5.7 in the supine position to 19.64 ± 5.601 mm in the prone position ($p < 0.001$) (Figure 7a). Similarly, LIA shows an elevation from 23.82 ± 8.35 to 25.97 ± 8.53 mm, emphasizing the impact of body positioning on these vascular parameters ($p < 0.001$) (Figure 7b). Moreover, RIV exhibits an increase from 22.35 ± 5.195 mm in supine to 25.02 ± 5.363 mm in prone ($p < 0.001$) (Figure 7c), while the LIV shows a rise from 14.68 ± 8.942 mm to 16.43 ± 8.981 mm ($p < 0.001$) (Figure 7d). These variations suggest a consistent trend of increased measurements in prone positions for both arteries and veins. The differences in the right and left iliac arteries are notable, with the supine mean at 43.97 ± 10.3 mm and the prone mean at 47.21 ± 10.62 mm ($p < 0.001$), indicating a significant change between the two positions.

In the prone position, the RIA exhibits a mean lateral movement of −2.13 ± 2.97 mm (Figure 7a), while the LIA demonstrates a lateral movement of −1.725 ±4.07 mm (Figure 7b). Similarly, the RIV and LIV both manifest substantial lateral movements of −2.673 ± 3.01 mm and −1.75 ± 2.92 mm, respectively (Figure 7c,d). Additionally, the distance between the R and L iliac arteries widens by 3.235 ± 4.39 mm ($p < 0.001$) in prone compared to supine (Figure 8).

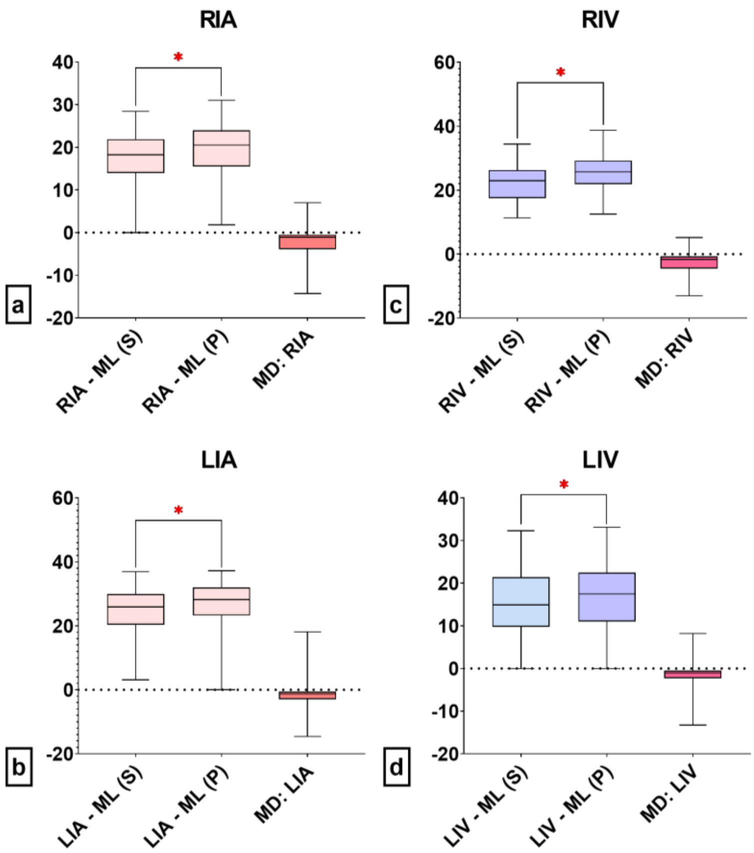

Figure 7. Differences in positional alignment between supine and prone postures of patients at the L5/S1 level in relation to the midline and iliac blood vessels: (**a**) Differences in the distance from the midline to the right common iliac artery (RIA) in supine (S) and prone (P) positions; (**b**) Differences in the distance from the midline to the left common iliac artery (LIA) in S and P positions; (**c**) Differences in the distance from the midline to the right common iliac vein (RIV) in S and P positions; (**d**) Differences in the distance from the midline to the left common iliac vein (LIV) in S and P positions; MD, mean difference; *, statistically significant differences ($p \leq 0.001$).

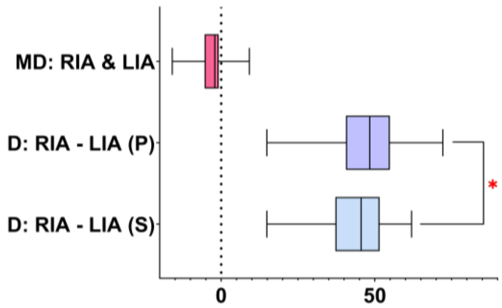

Figure 8. Differences in supine and prone positions of patients in relation to anterior and posterior contour of intervertebral disc and iliac blood vessels on L5/S1 level. RIA, right common iliac artery; (A), anterior contour of intervertebral disc; (P), posterior contour of intervertebral disc; LIA, left common iliac artery; RIV, right common iliac vein; LIV, left common iliac vein; *, statistically significant differences ($p \leq 0.001$).

4. Discussion

Patients with both acute and chronic back pain in the lower part of their spine sometimes require spine surgeries, such as microdiscectomies, and these procedures are risky. Therefore, the main goal of every operator is to avoid the development of any complications afterwards and to improve the quality of life of the patient. However, one of these complications could be the iatrogenic lesion of large blood vessels, such as the aorta or iliac arteries and veins. The occurrence of vascular damage as a result of disc surgery was initially documented in 1945 by Linton and White [13]. This occurs due to the complex anatomical relationship of these blood vessels with the vertebral body of vertebrae in the lumbosacral spine. The most frequent iatrogenic lesion occurs on the left common iliac artery due to its close anatomical contact with the body of the L4–L5 intervertebral disc. There is a wide palette of possible complications that have been noted by clinicians, such as injury to the left iliac artery, which ranges from loss of sensation to fatal rhabdomyolysis [14].

The incidence of vascular injuries during spine surgery varies between 0 and 18.1%, which is a very significant number. In addition, these complications have a large mortality rate of around 50%, usually due to the onset of hemorrhagic shock as a serious and life-threatening health condition [14,15]. Therefore, it is very important to initially mention the location of the aortic bifurcation and the location of the origin of the common iliac artery [16]. The research and discussion of every factor that has an impact on the decrease in the incidence of complications after spine surgery is important. The positioning of the patient during neurosurgical procedures has an important role in the avoidance of complications during spine surgery [17–20].

There is a very small number of studies dealing with the analysis of the anatomical relationship between the large blood vessels of the retroperitoneum and the structures of the lower segment of the lumbar spine. Hence, the possibility of damaging these blood vessels during surgical procedures, such as microdiscectomy, highlights the clinical importance of this and similar studies. Interestingly, the position of the common iliac arteries and veins is affected by the possible existence of congenital variations, which are noted in 0.4 to 4% of cases [18]. These variations occur in various forms, such as duplication of individual common iliac veins or the draining of one vein into the other. Other factors affect the position of blood vessels regarding the lumbar spine, and one of them is the aging process (namely, in older patients the iliac–caval junction moves distally [15]). The existence of these variations is also important to know, as they significantly increase the possibility of development of complications during surgery [21].

In everyday clinical practice, it is important to know the height of the bifurcation of the aorta and iliac blood vessels before spine surgery in order to avoid possible complications. A cadaveric study by Khamaronga et al. [14] showed that, in slightly more than 70% (70.12%) of subjects, the aortic bifurcation was located at the level of the L4 vertebra, while in 12.30% of subjects it was located at the level of the L4 intervertebral disc. At the level of the L5 vertebral body, aortic bifurcation was found in 17.6% of subjects. Another cadaveric study showed similar results, namely the study by Appaji et al. [15], which indicated that the most common site of aortic bifurcation was at the level of the L4 vertebra (55% of subjects). According to this study, the second most common location of the aortic bifurcation was at the level of the L3 vertebra (27.5%). Both mentioned studies showed that the localization of the bifurcation changes with age [15,17]. Cadaveric studies have been replaced by in vivo studies using radiographic methods, such as CT and MRI. Chithriki et al. [17] noted in their study, by using a sagittal MRI image for analysis to determine the height of the bifurcation, that 67% of subjects had an aortic bifurcation at the level of the L4 vertebra.

Several studies have shown very similar results when it comes to bifurcation of the aorta, and the place of origin of the common iliac artery can be precisely determined [15,17]. However, a very small number of studies have determined the position of the iliac blood vessels, and an even smaller number of studies analyzed the relationship and alterations of their positions in relation to the different positions of the body during surgery, such as pronation and supination. Vaccaro et al. [18] showed that common iliac vessels are closer to the anterior aspect of the intervertebral disc. In addition, the study showed that common iliac vessels are closer to the midline at L4–L5 as compared to L5–S1. When it comes to pronation, it was noted that prone positioning resulted in greater distances between the intervertebral disc and iliac vessels both at L4–L5 and L5–S1 by an average of 3 mm. In this, a slight predominance of females (55%) was noticed, while the average

age of the respondents was 56.07 ± 10.43 years. When looking at the BMI of the subjects, 26 subjects could be classified in the overweight group, 6 in the moderately obese group, while 17 subjects belong to the normal weight group.

This study also noted a highly significant difference between RIA in the supine and prone position, as well as LIA in the supine and prone position at the L4–L5 level. This continued with RIV and LIV. Also, similar results were gathered with RIA and LIA in both positions ($p < 0.001$), as well as RIV and LIV. Vaccaro et al. [18], in comparing supine and prone positioning, found statistically significant differences only in relation to the left iliac artery and anterior contour of the L4–L5 intervertebral disc. In their study, at L4–L5, the right and left common iliac arteries were an average of 5.4 mm (slightly higher than our 5.08 mm) and 2.9 mm (slightly higher than our 2.72 mm), anterior to the anterior aspect of the annulus at their closest point. A statistically significant difference with LIA ($p = 0.004696$) was also found in the study of Bečulić et al. [22], supporting our results. The radiological study by Behzadi et al. [23] also describes changes in the volume of the external iliac vein when shifting from the supine to prone position. Studies relying on ultrasound monitoring of pelvic blood vessels also support the idea that the patient's position affects the diameter of the blood vessels [24,25]. Fornek et al. [26] list gender and age as possible factors influencing the diameter of pelvic blood vessels, while Behzadi et al. [23] also consider ethnicity as a potential factor. In addition to morphometric changes, changes in patient position are accompanied by hemodynamic alterations [27–29]. This result implicates that the LIA is the most vulnerable for the artificial lesion, especially with microdiscectomy at the L4–L5 level [17,18,21,22,30,31]. Clinically, the associated vascular injury can manifest as a spectrum of severity, from massive hemorrhage to the development of arteriovenous fistulas and pseudoaneurysms [32–35]. Therefore, the early management of such vascular injuries may reduce mortality after spine surgery [34,36,37].

A few studies have analyzed the risk of iatrogenic lesion of retroperitoneal blood vessels by measuring the depth of intervertebral space. In a study by Antar et al. [37], the mean AP diameter at the level of L5–S1 was 39.97 mm for males and 36.99 mm for females. The safe zone was determined at the depth of 22 mm. Another study noted that the mean value of the AP diameter of the intervertebral disc at the level of L5–S1 was 43.8 mm in males and 40.1 mm in females. The mean transverse diameter for males and females was 59 mm and 55.6 , respectively [38].

There is a small number of studies that investigated the relationship between retroperitoneal blood vessels and the lower segment of the lumbar spine. A study by Vaccaro et al. [18] has shown the mean distance of RIA from the anterior contour of L4–L5 intervertebral disc to be 5.1 mm and 3.5 mm for LIA. The distance for iliac veins is notably smaller, such that the distance of RIV is 0.6 mm and 0.3 mm for LIV. This study showed a statistically significant difference in the distance of RIA and LIA from the anterior and posterior contours of intervertebral discs at the L5–S1 level in the supine and prone position. Significant differences between the supine and prone positions were shown for RIV and LIV as well [18]. In the study by Ganesan [39], the average distance from the anterior L5–S1 intervertebral disc for males was 7.2 mm and 9.6 mm for RIA and LIA respectively. For females, the distance for RIA was 7.9 mm and 9.8 mm for LIA. This study did not show any difference in relation to the patient positioning. The mean distance of arteries at the level of L4–L5 was 4.3 mm in the supine and prone position [39]. A study by Marchi et al. [40] showed the areolar space to be narrow in the supine position, especially in the lower lumbar segment. The same study also indicated that the areolar space could be maximized in the lateral patient position, while the average values of areolar space in relation to inferior vena cava were larger in the superior lumbar segment.

By changing the position of the body, blood vessels move anteriorly, but this movement is of no statistical significance [41,42]. The average distance of the right common iliac artery from the anterior contour of the disc in pronation is 5.4 mm, the left iliac artery 2.9 mm, while both veins are 0.8 mm apart. Another study showed statistically significant anterior movements of LIA with the change in body position from supine to prone [22]. This study also showed that there is a significant difference in the relationship of LIA with the anterior contour of the intervertebral disc in the supine and prone position, as the distance of LIA changed by 2.13 mm at the level of L5–S1 with the change from supine to prone. Statistically significant movement was noted for RIV, as it measured 2.673 mm at the level of L5–S1. This movement was not bound by gender, height, nor BMI. There was also no significant movement noted of LIV at the level of L5–S1. However, there are some statistically significant movements of retroperitoneal blood vessels in relation to the posterior contour of the intervertebral disc at the level of L5–S1. RIA moves anteriorly by 2.04 mm, LIA by 1.273 mm, RIV by 1.69 mm, and LIV by 1.273 mm. By understanding these relationships, the occurrence of artificial lesions in blood vessels during spinal surgical procedures can be prevented [43]. To prevent potential damage to blood vessels, it is recommended to mark surgical instruments with distance indicators from the instrument tip to facilitate their visualization during disc surgery [44–46]. Furthermore, limiting instrument penetration into the disc within the range of 25 to 30 mm is advised [47–49]. However, caution should be exercised in applying these recommendations to avoid a potentially misleading sense of security [50]. Additionally, the depth of insertion along the anterior–posterior axis can be influenced by the orientation of instrument insertion.

The study's limitations include its small sample size and a monocentric design, raising concerns about the generalizability of its findings beyond the specific study population and setting.

5. Conclusions

In conclusion, there is a limited body of research on this subject, and there is a scarcity of data regarding the optimal surgical approach to preventing iatrogenic injuries to retroperitoneal blood vessels. Our study is among the few that have investigated the association between retroperitoneal blood vessels and the lower lumbar spine. Our findings highlight the significant influence of patient-specific positions in the relationship between iliac blood vessels and lumbar intervertebral discs. Therefore, it is crucial to educate operators about the positional changes of these large retroperitoneal blood vessels in relation to the lumbar spine, as this knowledge can potentially enhance the outcomes of microdiscectomy and other spinal surgeries.

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