ORIGINAL ARTICLE

Morphometric study of the anatomic relationship between large retroperitoneal blood vessels and intervertebral discs of the distal segment of the lumbar spine: a clinical significance

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ABSTRACT

Aim To analyse potential clinical implications of the distance between large retroperitoneal vessels and lower segment of the lumbar spine in the supine and prone position.

Methods Prospective, non-randomised study included 40 patients of different age and gender. For all patients magnetic resonance imaging of the lumbar spine was performed in supine and prone position. The level of aortal bifurcation, common iliac vein confluence, the distance from the anterior and posterior aspect of the annulus to the posterior wall of the large retroperitoneal vessels were analysed.

Results The study included 40 patients, 22 (55%) males and 18 (45%) females. The level of aortal bifurcation was higher in prone compared to supine position ($\chi 2 = 29.88571$; $p<0.05$). In supine and prone positions, the common iliac veins confluence was most commonly at the level of the lower third of the L4 vertebra ($p>0.05$). There was a statistically significant difference between the distance from the left common iliac artery to the anterior contour of L4/L5 intervertebral disc ($p<0.05$).

Conclusion Knowledge of the anatomic relationship between iliac vessels and structures of the lower segment of the lumbar spine is very important in the prevention of a potentially severe complication, such as artificial common iliac vessels rupture. Our study showed that the risk of lesions of the common left iliac artery was lesser in the prone position.

Key words: iliac artery, iliac vein, magnetic resonance imaging, prone position, supine position

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INTRODUCTION

Anatomically, the lumbar spine could be divided into two segments: an upper segment (L2-L4) and lower segment (L4-S1) (1,2). The large retroperitoneal arteries and veins are placed anteriorly from the lumbar spine (3). Aorta and inferior vena cava are located in front of the upper segment of the lumbar spine, but common iliac arteries and veins are located in front of the lower segment of the lumbar spine (1). The knowledge of the anatomical relationships in this region is very important for the surgery, especially for posterior neurosurgical approaches such as microdiscectomy (4).

The iatrogenic injury of large vessels is a very rare complication, with the incidence of 0.01 to 0.05%. This is a devastating complication and has a significant mortality rate (about 65%) (5,6). The left common iliac is most commonly damaged due to its more medial course and close interrelationship with L4/L5 intervertebral disc space separated only by the anterior longitudinal ligament (7).

Numerous studies have reported the relationship between large retroperitoneal vessels and lumbar spine (4,8,9). These studies were conducted while patients were in a supine position. These studies did not acquire the possibility of a change of anatomical relationship during the prone position, which is used during the micro discectomy (4, 8-10). In the literature, there is only one study which investigated the relationship between large vessels and lumbar spine in prone (1).

The aim of this study is to analyse the anatomical relationship between large retroperitoneal vessels and lower segment of the lumbar spine in supine and prone position, as well as the clinical significance of these anatomical relationships.

PATIENTS AND METHODS

Patients and study design

This prospective, non-randomised study included 40 patients (22 males and 18 females) with low back or radicular pain, different age and gender attended to the Cantonal Hospital Zenica during the period January to December 2018. All patients were previously scheduled for magnetic resonance imaging (MRI).

Body height, weight and body mass index (BMI) were measured in all patients. Patients with a history of abdominal or pelvic surgery, any operation on the lumbar spine and retroperitoneal surgery were excluded from the study. Also, patients with verified inflammatory and expansive lesions in the retroperitoneal space, aneurysms of the aorta and its terminal branches, expansive lesions of the vertebrae, massive disc herniation, spondylolisthesis, scoliosis and kyphosis of the lumbar spine, were also excluded from the study.

The study was conducted with the approval of the Ethics Committee of the Cantonal Hospital Zenica. All patients signed informed consents.

Methods

In all patients MRI (Siemens Magnetom Avanto 1.5 T, Erlangen, Germany) of the lumbar spine was performed in the supine position as a standard protocol of the study (1.5 T MRI, T1 and T2 sequences in axial, sagittal and coronary level). Patients were placed in the prone position, with the chest and hip rolls, so that the abdomen was free of compression. This position is the same as for the dorsal approach during a surgery of the lumbar spine. MRI of the lumbar spine (MRI 1.5 T; T1, T2 sequence in axial, sagittal and coronary level) was done in the prone position. All scans were transferred to the IMPAX system (Agfa Impax 6.5.3.2525 Healthcare), which enables the analysis and measurement of anatomical structures in all planes. All measures were performed by the authors and monitored by a neuroradiologist.

The position (level) of aortal bifurcation and common iliac vein confluence were analysed by dividing the vertebral body into three parts according to the vertical plane (upper third, middle third and lower third). The following morphometric parameters were analysed: height of the aortic bifurcation, height of confluence of two common iliac vein to the inferior vena cava, the distance from the anterior aspects of annulus to the posterior wall of the large retroperitoneal vessels (common iliac arteries and veins, inferior vena cava, aorta), the distance from the posterior aspects of annulus to the posterior wall of the large retroperitoneal vessels, the distance of large retroperitoneal vessels from the midline, and distance between iliac arteries and veins. All parameters were analysed for each patient. Changes of the position and relationship

of blood vessels and the structures of the lower segments of the spinal column were analysed in relation to the change of body position (supine, prone) as well as in relation to the height, weight and BMI. The focus of our study was to analyse the relationship of large retroperitoneal blood vessels and intervertebral discs of lower segment of the lumbar spine (L4/L5 and L5/S1).

Statistical analysis

The methods of descriptive and comparative statistics ($\chi 2$ test) were used. Results were presented in tables and expressed as relative and mean values. Statistically significant difference was set to less than 5%.

RESULTS

The study included 40 patients, 22 (55%) males and 18 (45%) females. The youngest patient was 26 and the oldest 69 years (average 53.57 years) of age. The average height of patients was 175.375 cm (males were higher than females). According to the BMI values, the largest number of patients was in the obese group, without any statistically significant difference between males and females (p>0.05).

The level of aortic bifurcation was higher in the prone compared to the supine position (p<0.05) (Table 1). There was no statistically significant difference between the level of aortic bifurcation and gender in the supine (p>0.05) and prone position (p>0.05). We did not find statistically significant difference between the level of aortic bifurcation and BMI in the supine (p>0.05) and prone position (p>0.05).

Table 1. The level of aortic bifurcation in supine and prone position

Level of aortic bifurcation	Supine (%)	Prone (%)
Middle 1/3 of L3 vertebra	0.00	2.50
Lower 1/3 of L3 vertebra	2.50	2.50
Upper 1/2 of L3/L4 intervertebral disc	0.00	2.50
Lower 1/2 of L3/L4 intervertebral disc	5.00	5.00
Upper 1/3 of L4 vertebra	17.50	20.00
Middle 1/3 of L4 vertebra	20.00	32.50
Lower 1/3 of L4 vertebra	35.00	17.50
Upper 1/2 of L4/L5 intervertebral disc	7.50	2.50
Lower 1/2 of L4/L5 intervertebral disc	5.00	7.50
Upper 1/3 of L5 vertebra	5.00	2.50
Middle 1/3 of L5 vertebra	2.50	2.50
Upper 1/2 of L5/S1 intervertebral disc	0.00	2.50

There was no statistically significant difference between the level of common iliac veins confluence and patient's position (p>0.05). A statistically significant difference of gender (p>0.05) and BMI (p>0.05) relating to level of common iliac veins confluence was not found.

Statistically significant difference between distance from the left common iliac artery and the anterior contour of L4/L5 intervertebral disc was found (p=0.004696) (Table 2).

Table 2. Differences of distances of large retroperitoneal vessels from contours of L4/L5 disc in supine and prone positions

	Anterior contour of L4/L5 intervertebral disc	Posterior contour of L4/L5 intervertebral disc
Blood vessel	p	p
Right common iliac artery	0.090968	0.432722
Left common iliac artery	0.004696*	0.403997
Right common iliac vein	0.340085	0.255
Left common iliac vein	0.447392	0.471134

*statistically significant difference

There was no statistically significant difference between BMI and common iliac vessels distance from the anterior and posterior contour of the L4/L5 disc (p>0.05). In the female patients the right iliac vein was placed more anteriorly from the anterior contour of the L4/L5 intervertebral disc in the prone position (Table 3).

Table 3. Differences between male and female patients in distances of common iliac vessels from contours of L4/L5 disc in supine and prone position

L4/L5 intervertebral disc	Common iliac vessel	Supine	Prone
		p	p
Anterior contour	**Right common iliac artery**	0.215949	0.096026
	Left common iliac artery	0.133714	0.394082
	Right common iliac vein	0.405894	0.057296
	Left common iliac vein	0.303721	0.1876
Posterior contour	**Right common iliac artery**	0.275644	0.318161
	Left common iliac artery	0.376288	0.4232
	Right common iliac vein	0.253837	0.004557*
	Left common iliac vein	0.231369	0.441901

*statistically significant difference

Statistically significant difference from the left common iliac artery to the anterior and posterior contour of L5/S1 intervertebral disc was found (p>0.05). There was no statistically significant difference between BMI and common iliac vessels distance from the anterior and posterior contour of the L5/S1 disc (p>0.05).

DISCUSSION

Microdiscectomy is one of the most common types of operation in neurosurgery (1). About 1-3% of patients with chronic radicular pain

require surgery (3,4). Today, microdiscectomy is a routine operation in neurosurgery. However, there are many complications of this operation (11). The most serious complication of microdiscectomy is artificial lesions of the large retroperitoneal blood vessels, usually common iliac arteries and veins (12). Fortunately, this complication is very rare. The incidence of these complications is about 0.01 to 0.05%, but mortality is over 50%, according to some authors even more than 70% (1,13,14). Since the microdiscectomy is usually performed in the lower segments of the lumbosacral spine (L4/L5 and L5/S1), this might lead to the lesions of the common iliac artery and vein (7,10). In most cases the resulting lesions of the left iliac artery occur due to an intimate relationship of this artery and L4/L5 intervertebral space, and because of a more medial pathway of this artery (1). There are numerous risk factors that predispose a lesion of retroperitoneal blood vessels such as previous disc surgery, degenerative changes and weakening of the annulus, adhesions of the annulus and anterior longitudinal ligament, aggressive surgical approach, anomalies of the spine and surrounding structures, etc. (15,16). The lesion of the large retroperitoneal blood vessels results in a catastrophic haemorrhage and haemorrhagic shock (17). In spite of low incidence, the artificial lesions of retroperitoneal large vessels require special attention because of high mortality (14,16). There is a number of methods that are trying to assess the risk of these complications (9). Nilsonne and Hakelius performed the first research about the risk of artificial lesion of retroperitoneal large vessels during microdiscectomy, using lateral view radiography and application of contrast in the large vessels (1,8). However, numerous other studies were performed on cadavers, CT and MRI (2,4, 8-10). These studies had limitations, because they did not consider the possibility of a change of the anatomical relationships between large retroperitoneal blood vessels and lumbar spine with different positioning of the patient (1,18).

In the literature there is only one study which analysed the relationship between the vital retroperitoneal blood vessels and lower segments of lumbosacral spine in supine and prone position (1).

In most cases aortic bifurcation is located at the level of L4 vertebra (8). Khamanarong et al. found that aortic bifurcation is placed at the level of L4 vertebra in 131 cases (70.1%), at the 4th lumbar intervertebral disc in 12.3% and at the level of L5 vertebra in 17.6% patients (19). These results were confirmed in our study. We confirmed that the level of aortic bifurcation was not dependant on gender, height or BMI. Most commonly, iliac vein confluence is located at the level of L5 vertebra (1). Regarding the level of common iliac vein confluence, in supine and prone positions it was most common at the level of the lower third of the L4 vertebra. Our research showed that the level of aortic bifurcation was higher in prone compared to the supine position. In the supine and prone position, the common iliac veins confluence was usually created at the level of the lower third of the L4 vertebra, but without any statistically significant difference between supine and prone position.

According to Vaccaro et al. all four iliac vessels drifted anteriorly in the prone position. They found statistically significant difference only in relation to the left iliac artery and anterior contour of the L4/L5 intervertebral disc (1), which corresponds with our results. This is very important because the left iliac artery lies on the anterior contour of the L4/L5 intervertebral disc. Therefore, the left common iliac artery is the most vulnerable for the artificial lesion, especially during microdiscectomy at the level of L4/L5 (20,21). Our study showed that in female patients the right iliac vein was moved anteriorly from the anterior contour of the L4/L5 intervertebral disc in prone position; additionally, the distance of common iliac vessels from the anterior and posterior contour of the L4/L5 and L5/S1 disc did not depend on the gender and BMI, and the position of a patient did not affect the position of the iliac vessels at the level of L5/S1.

In conclusion, this research showed that the changes of the body position have significant effect on the anatomy of retroperitoneal blood vessels, especially on the position of the left common iliac artery. In the prone position the left common iliac artery is turned anteriorly. This is very important because the left common iliac artery is the most vulnerable vessel for artificial lesions during the surgery. The knowledge of the anatomic relati-

onship between iliac vessels and structures of the lower segment of the lumbar spine is very important in neurosurgery. It could help in the prevention of potentially catastrophic complications such as the artificial common iliac vessels rupture.

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TRANSPARENCY DECLARATIONS

Competing interest: none to declare.

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