Commentary on:
Anatomic Study of the Lumbar Segmental Arteries in Relation to the Oblique Lateral Interbody Fusion Approach **by Wu et al. World Neurosurg 2020**
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Avoiding Lumbar Segmental Arteries Injury in Oblique Lateral Interbody Fusion Procedure

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Lumbar interbody fusion is performed to treat several spinal disorders and involves the insertion of a structural graft into an intervertebral disk space to promote bony arthrodesis.

Although the posterior approach to the lumbar spine was long the most frequently adopted surgical strategy to perform fusion, anterior approaches, first introduced in 1906,[1] have recently blossomed. Patient expectations and increasing demands for shorter hospital stay and early recovery have led to more innovative surgical techniques to reduce iatrogenic injury and postoperative morbidity. Depending on the level to be treated, several approaches have been developed, each dealing with peculiar anatomic obstacles: pure anterior, oblique anterior or lateral, and transpsoas or prepsoas. These operations can be performed using miniopen or minimally invasive approaches without clear definitive evidence for 1 approach being superior to another in terms of fusion or clinical outcomes.

Minimally invasive surgery lumbar lateral interbody fusion approaches allow surgeons to reach the anterior spine and perform interbody fusion by cage placement. Two popular surgical procedures are available for lumbar lateral interbody fusion: oblique lateral interbody fusion (OLIF) and extreme lateral interbody fusion. OLIF, with a route between the left lateral border of the aorta and the anterior medial border of the psoas allows minimal access to the anterior portion of the intravertebral disk (IVD), thus avoiding direct intraoperative/postoperative neural injury as reported for extreme lateral interbody fusion surgery.[2,3] Such an approach does not require posterior surgery and does not dissect or traverse the psoas muscle. The extreme lateral interbody fusion technique is suitable for levels L1 to S1 without neuromonitoring need since the corridor anterior to the psoas muscle prevents against neural injury. Indications for OLIF include degenerative, traumatic, and scoliotic conditions of the spine. Its use, however, is contraindicated in patients with severe central canal stenosis and high-grade spondylolisthesis.[4] Main advantages of the OLIF approach include rapid postoperative mobilization, effective deformity correction, high fusion rates, and complete disk space restoration.[4-6] However, potential risks are sympathetic dysfunction and vascular injury[6] including the segmental vessels branching from the aorta or vena cava, as well as the great vessels lying on the anterior spine.[7] Injury to these vessels may cause massive and deadly intraoperative bleeding or injury to nearby neurovascular structures, such as the lumbar plexus and femoral nerve.[7,8] Segmental vessel injury can also happen during pin fixation to the vertebral body, resulting in death in up to 40% of cases when great vessels are injured.[9]

To avoid these complications, which are difficult to manage because of the narrow working space during the approach, some studies have described the precise morphology of the branches of the lumbar artery at the extraforaminal area at the disk level.[10,11] It has been observed that the anastomotic

Key words
- Computed tomography angiography (CTA)
- Lumbar segmental arteries
- Oblique lateral interbody fusion (OLIF)
- Radiologic evaluation

Abbreviations and Acronyms
CT: Computed tomography
IVD: Intravertebral disk
MRI: Magnetic resonance imaging
OLIF: Oblique lateral interbody fusion

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arteries run vertically almost 4 mm anterior to the base of the transverse process[11] and are present in all levels but prevalent between L4 and L5, suggesting that the risk of bleeding is higher during surgery at these levels.[12] By using contrast-enhanced computed tomography (CT), several variations of distributing arteries from the lumbar artery to the posterior element of L4–L5 have been identified.[13] Subsequent studies have shown that branches of the Q2 lumbar artery appeared more frequently on the posterior third of the L4–L5 intervertebral disk, suggesting that particular care should be taken when approaching the disk through the psoas muscle, performing contralateral disk excision through the disk space, and inserting interbody cage can cause injury of lumbar arteries with postoperative retroperitoneal hematoma.[5,14,15]

Location and involvement of lumbar segmental arteries have been evaluated in a virtually prepared OLIF surgical field by using magnetic resonance imaging (MRI).[16] The branch angles of the segmental arteries were significantly acute (≤90°) in L1–L3 and significantly blunt (>90°) in L4 and L5. The average distance from the segmental arteries to the center of the cephalad adjacent IVD was significantly large at L5 with a significant rate of adjacency to the IVD, indicating that the L5 segmental artery can interfere with the surgical route of the OLIF procedure.[16] Recently, MRI of patients with lumbar disease has shown that lumbar vessels are not necessarily located at the center of the vertebral body since many individual differences occur, especially in L4, where the lumbar vessels verge down from the anterior cranial side to the posterior caudal side.[17]

However, results coming from MRI can suffer from a low ac- Q3 curate image plan or resolution, thus rising false-negative/positive findings. Also, with MRI is almost difficult to distinguish between the lumbar artery and vein, and blood vessels between vertebral bodies connecting between lumbar veins. Thin-slice CT scans with contrast, instead, would give better results.

In this issue of **WORLD NEUROSURGERY** Wu et al[18] describe the regional anatomy of the lumbar segmental arteries associated with the OLIF surgical field and analyze the clinical significance regarding the risk of their intraoperative injury by using CT angiography. Briefly, the authors collected 3-dimensional imaging data from 50 adults who underwent abdominal CT angiography for urinary or intestinal diseases. Distances from the lumbar segmental arteries to the upper and inferior edges of the vertebral body were measured in the anterior quarter of the anterior and median lines of the IVD. Lumbar segmental arteries were classified as types I–IV based on the zone in which they passed through the vertebral body. On the basis of the results obtained, the authors concluded that risk of lumbar segmental arteries injury is higher in zone IV of L3–L5. Furthermore, the pin should be fixed on the upper edge of the lower vertebral body at L1–L2 and L2–L3, as well as on the lower edge of the upper vertebral body at L3–L4 and L4–L5, to avoid complications.

Though this study involves potential biases because it is based entirely on imaging lacking an appropriate comparison with a surgical or cadaver settings, it excludes a priori unusual anatomic variations or pathologic conditions, such as a transitional spine or fractured and misaligned spinal column, which could be encountered in clinical practice.

Despite everything mentioned earlier, this study provides an elegant vascular atlas for navigating a critical area and a number of useful recommendations regarding safe thresholds for sparing lumbar segmental arteries during the OLIF procedure. Also, the information provided suggests the importance of preoperative neuroimaging investigations to detect abnormal arteries that could cause unexpected bleeding.

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