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Two level Anterior Lumbar Interbody Fusion (ALIF) in a patient with a rare vascular malformation, a duplication of the inferior vena cava

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Abstract:
Background: Anterior Lumbar Interbody Fusion is now a well-established procedure to treat degenerative lumbar disease. This approach has its own risks and each spine surgeon must understand the pitfalls that can be encountered when dealing with an anatomy variation of the vessels in order to be able to perform the safest possible procedure.

Case Description: We report the case of a 48 years old man with a rare vascular anatomy variation undergoing a two-levels L4-L5 and L5-S1 ALIF procedure through a right-sided retroperitoneal approach. The preoperative imaging planning revealed a duplication of the Inferior Vena Cava (IVC) located on each side of the aorta.

Conclusion: Preoperative Imaging evaluation and a detailed knowledge of the anatomy is the key of a safe and successful procedure as any variation can complicate the anterior approach. We believe that teaming up with a vascular surgeon for junior surgeons during the first anterior procedures and especially in the context of anatomical variation is recommended.

Key Words: Anterior Lumbar Interbody Fusion; Vascular anomalies; Duplication inferior vena cava, spine surgery complications

Abbreviations and Acronyms:
ALIF : Anterior Lumbar Interbody Fusion
IVC : Inferior Vena Cava
CT-Scan : Computerized tomography scanner
MRI : Magnetic Resonance Imaging
TLIF: Trans lumbar Interbody Fusion
Introduction:

Anterior lumbar interbody fusion (ALIF) was first described in 1906 (1) and is now well established as a safe and efficient fusion procedure (2) (3). This procedure allows access to a large surface of the disc, helping the surgeon to perform an effective and complete discectomy with a high fusion rate (4).

Each surgeon must be fully aware of the anatomical relationships and its possible variations in the retroperitoneal region in order to minimize vascular risks, certain intraoperative complications can quickly lead to life-threatening situations (5). To our knowledge few studies published in literature describe ALIF cases performed in patients with congenital vascular anomalies.

A recent meta-analysis (6) established that the overall prevalence of duplication of the inferior Vena Cava in the population was 0.7% (95% CI between 0.5% and 0.9%).

We report a case of duplication of the inferior vena cava during an ALIF on two levels (L4/L5, L5/S1).

Case Report:

A 48-year-old active man had chronic low back pain with a medical history of spine surgery in 2015 for lumbar stenosis (bilateral recalibration of the lumbar canal at level L4-L5 and L5-S1, with L4-L5 discectomy). The surgery went well at that time with no complications. Since March 2019 the patient presented with the upsurge of low back pain (inflammatory and mechanical pain) and a left S1 radiculopathy without any sensitive or motor deficits. The patient underwent a period of nonoperative treatment including physical therapy and optimal medical treatment without effect on the symptoms, the patient remained unable to work.

The last MRI showed 2 inflammatory discs at L4-L5 and L5-S1 level, a L5-S1 recess stenosis and herniated disc. We discussed all surgical options with him to relieve his symptoms and we decided to perform an anterior fusion at L4-L5 and L5-S1 levels.

Informed written consent was obtained after having explained all risks and benefits of the surgical procedure in detail.

Preoperative CT-scan and MRI revealed a rare vascular anatomical variation: the duplication of the inferior vena cava. Because of the vascular anatomy we decided to perform a right sided retroperitoneal approach instead of the common left sided approach for the L4/L5 level.
Figure 1: A) Axial section of the preoperative CT-scan at L4/L5 disc level, we can see the duplication of the inferior vena cava on each side of the aorta ; B) Axial section at the L5/S1 disc level ; C) Coronal section, aorta is identifiable with calcifications; D) Sagittal section of the CT-scan
After general anesthesia and endotracheal intubation, the patient was positioned supine and the L4-L5 and L5-S1 levels were confirmed by a C-ARM X-ray.

A 5 cm vertical midline abdominal incision was first done. We then performed a right-sided retroperitoneal approach, we decided to start by the L5-S1 level. We reclinated the right ureter with the peritoneum, then we exposed the L5-S1 disc in the bifurcation of the left inferior vena cava. We used «Endoring » autostatic retractor (Medtronic Sofamor Danek, Memphis, TN) for the exposure with 4 steinmann nails.

The L5/S1 disc space was cleared, endplates preparation was done and an interbody cage packed with bone graft taken from the right iliac crest was inserted (ROI-A ALIF CAGE Zimmer Biomet). Because of the anatomy variation, the L4/L5 approach was done between the right inferior vena cava and the aorta. During the approach, we noticed a small vascular injury without major blood loss on the right inferior vena cava successfully treated with a Prolene 5/0 suture. We then had to place two clips on the iliolumbar vein when approaching the L4 / L5 disc in order to avoid putting excessive tension on it which could have led to significant intraoperative bleeding. As for the L5/S1 level we successfully inserted a ROI-A ALIF cage at the L4-L5 level.

Perioperative Xray control confirmed the good position of the interbody devices. Except the vascular injury we didn't have any other perioperative or postoperative complications. The patient was discharged at Day 3 after surgery and noticed improvement in low back pain and leg pain. We also introduced a low-molecular-weight heparin therapy for 10 days after discharge. A postoperative X-ray imaging demonstrated adequate position of cages at L4-L5 and L5-S1 levels. At 6-week postoperative follow-up, the patient presented no recurrence of symptoms.

**Figure 2: Origin of the left inferior vena cava with only renal anastomosis, the supracardinal vein**
**Figure 3:** Postoperative anterior-posterior control X-ray

**Figure 4:** Peroperative view of the anatomical variation
**Discussion:**

Anatomical anomalies affecting the inferior vena cava (IVC) have been known since 1793 when Abernathy presented to the Royal Society the case of a 10 months old child (7).

The inferior vena cava system results from the evolution of three symmetrical venous elements: the posterior pre-ureteral cardinal system running along the internal edge of the mesonephros (Wolff's body) which appears at the 4th week, the subcardinal system more medial and more ventral that the previous one which appears at the 6th week, and finally the supracardinal system, which will be dominant compared to the two other systems, in dorsomedial orientation compared to the posterior cardinal system, with retro-ureteral path, appearing to him at the 7th week and coming to meet the lumbar lateral sympathetic vertebral chain (8)(9).

In our case the duplication of the inferior vena cava in the lumbar region is characterized by the persistence during embryological development of the two right and left supra-cardinal veins at equivalent flow rate which evolve in parallel. This then results in a venous canal joining the left primary iliac vein to the left renal vein called the left sacro-cardinal vein (Figure 2) (8) (10). Morita et al. (11) also described the different vascular position of the IVC using a classification. We identified in our case a type 2a situation as described before (figure 3).

**Figure 5:** Morita et al. Classification system: We are here in a 2A type of duplication of the inferior vena cava with no interiliac anastomosis. (6)

We also believe that it is important to keep in mind for every spine surgeons that there are certain differential diagnoses that can be misleading. We can therefore find lumbar-aortic retroperitoneal lymphadenopathy on various neoplasias (tumor of the seminomatous testicle, non-Hodgkin's lymphoma ... ). One of the classic but rare traps is the presentation of a lower double vena cava in retroperitoneal lymphadenopathy (12). The other diagnostic traps in abdominal sectional CT imaging are an enlargement of the left spermatic or ovarian vein, an aneurysm of the subrenal abdominal aorta, an enlargement of the diaphragmatic pillars, a left pyeloureteral dilation, a jejunal loop incarcerated in a paraduodenal dimple, a horizontal section of the fourth portion of the duodenal framework or even a small pancreatic pseudocyst (8)(13).
Barrey et al. (14) reported an evaluation of the vascular anatomy of abdominal vessels with 3D CT angiography and developed the concept of vascular window that every spine surgeon who wants to perform an anterior approach should have in mind. He described a vascular window at L4-L5 (distance between the lateral border of ilio-cavum vein and lateral border of L4-L5 disk), and a vascular window at L5-S1 (distance between the most medial iliac vascular structure (artery or vein) on the right side and the most medial iliac vascular structure (artery or vein) on the left side) (14). Defining this vascular window before the surgery makes it possible to anticipate the mobilization of the vessels that it will be necessary to do, this making it possible to make the gesture safer.

The careful pre-operative planning allowed us to highlight this vascular malformation and to adapt our surgical approach accordingly. The vascular window was, in our opinion, large enough to allow us to perform this procedure safely.

We also preferred to continue with our initial indication because of the history of posterior surgery and resulting postoperative fibrosis with an increased risk of dural breach, but a TLIF could have been a possible solution for the patient. In our spine surgery center, we believe that the risk of pseudarthrosis is less important with an ALIF than by the posterior approach for the L5/S1 disc, which also guided our therapeutic indication. We believe that it is important that each spine surgeon masters all surgical techniques in order to adapt to each patient and not to systematically propose the same technique.

We were also interested in the risk of thromboembolic event in this context of duplication of the inferior vena cava. Few studies in the literature consider that this anatomical variation can be the cause of spontaneous deep vein thrombosis (15)(16). However, it seems that there is a link if the anatomical variation is not diagnosed upstream and that there are coagulation anomalies (17). The absolute increase in risk still remains to be defined but some authors estimate a 6,5% risk increase of deep vein thrombosis. We then preferred to introduce for our patient a preventive heparin therapy for 10 days because of the surgical context and this anatomical variation.

We did not perform postoperative abdominal CT angiography with venous time because the venous wound was minimal and our suture was solid without leakage associated at the end of the intervention.

Some authors in the literature described interesting surgical approach in the context of inferior vena cava anomaly: a left sided vena cava and right sided aorta in an ALIF and an OLIF procedure (18) (19). We strongly recommend for every spine surgeon to pay particular attention to the vascular anatomy on the coronal and axial imaging when deciding to perform an Anterior or Oblique approach of the lumbar spine. Access to 3-dimensional imaging exams is getting easier these days. This allows surgeons to have a very precise vision of the operating strategy in order to adapt to each situation, particularly in the event of anatomical variation.

We do also recommend for the younger surgeons to work in team with a vascular surgeon or an access surgeon in order to get a precious help when planning and performing the spinal fusion procedure by anterior way.

**Conclusion:** This clinical case shows that even in case of anatomical variation it is possible to undertake ALIF surgery by planning the intervention carefully. However, keep in mind that
the surgeon must adapt to each patient in order to offer the safest and most effective procedure. Do not hesitate to work as a team in certain delicate situations

Consent: Written consent was obtained by the patient

Conflicts of interest: We have no conflicts of interest

References:


Legends:

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