Original Article

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A Study of Morphology and Relations of Iliocava Junction to Aortic Bifurcation and Lumbosacral Vertebrae

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Abstract

Growing interest of surgeons in anterior approach to lumbar spine has demonstrated its vascular complications. A clear delineation of vascular working window for operating lumbar spine, formed by inferior vena cava formation and Aortic bifurcation is important to avoid dangerous complication. This study determines common level of Aortic bifurcation at the body of L4, with average distance of 34mm from lower border of L5-S1 disc. Variable level of iliocava junction (formation of inferior vena cava) was noted from body of L4 to L5-S1 disc, with average distance of 17mm from lower border of L5-S1 disc. Average width of inferior vena cava measured maximum at its formation i.e. 28mm. Width of right and left common iliac vein found almost equal. Angle made by left common iliac vein with inferior vena cava found most variable whereas that with right common iliac vein was constant. Average interiliac angle was 72.5 degrees. Left common iliac vein showed average 3 tributaries while right showed none or 1.

Key words: Iliocava junction; Aortic bifurcation; Lumbosacral spine.

Introduction

Venous anatomy is known for variations. Lots of variations of inferior Vena cava are encountered during cadaveric dissection and while operating on lumbosacral spine. Variations of its formation (Iliocava Junction) are the most common amongst them.

Prolapsed intervertebral disc or malignant vertebral tumors and even vertebral body fusion procedures are common indications for surgeries for low back pain. Posterior approach to this region has been recorded less satisfactorily, which led to a growing interest in anterior approaches to the lumbar spine. Anterior approach lumbar surgery and reported results from laparoscopic surgery have demonstrated that such approach can be associated with dangerous vascular complications.This makes detail study of vasculature at lumbosacral spine specially iliocava junction vital.(1)

The CT study by Svin Anda ,Svend Aakhus, Karl Ove Skaanes reported that inferior vena cava and left common iliac vein which forms vascular working window of operating field have a larger transverse diameter and lie closer to the disc than do the arteries. Because veins have considerably thinner wall than arteries, veins can be inadvertently hit and punctured resulting into formation of hematoma with false aneurysm or arteriovenous fistulas.(2)

A clear delineation of vascular anatomy and its relationship to the disc space would provide useful information to the surgeon for the approach to the field, especially during laparoscopic procedures . Study may be useful for radiologist to determine types of variations. This study is done for assessment of morphology of iliocava junction and defines its relationship with lumbosacral spine and aortic bifurcation.

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Aim and Objectives

To study Aortic Bifurcation with respect to:

- Vertebral level
- Distance from lower border of L5 vertebra
- Width

To study Iliocava junction with respect to:

- Vertebral level ,
- Variations of formation, Iliocava junction position (above or below aortic bifurcation) .
- Width of iliocava junction.
- Width of inferior vena cava 2 , 3 and 4 centimetres above iliocava junction .
- Distance between aortic bifurcation and iliocava junction.
- To measure angle between two common iliac veins,
- Angle between inferior vena cava and right common iliac vein,
- Angle between inferior vena cava and left common iliac vein.
- To measure width of right and left common iliac vein.
- To measure distance between two common iliac veins at lower border of L5 vertebra.
- To determine number of tributaries opening into iliocava junction and both the common iliac veins.

Material and Methods

This study was done on inferior vena cava of 60 cadavers. Cadavers were embalmed with 10% formalin. The cadavers used were first dissected by First MBBS students. Students dissected anterior abdominal wall, studied abdominal viscera. They were asked to preserve inferior vena cava for measurements of study according to proforma.

Area of study included aortic bifurcation, iliocava junction with proximal 4 cm segment of inferior vena cava and first sacral & lower lumbar vertebrae. Area dissected meticulously and all soft tissue made free from surrounding fat. Clotted blood in inferior vena cava removed.

Position of aortic bifurcation noted. Its distance from lower border of L5 vertebra measured (Height of aortic bifurcation) with measuring tape. (Illustration 1) Width of aortic bifurcation measured.

Position of inferior vena cava noted with respect to its vertebral level, either right or left to aortic bifurcation and either above or below aortic bifurcation. Distance of formation of inferior vena cava (Iliocava junction) from lower border of L5 vertebra measured (Height of Iliocava junction). Width of Iliocava junction measured. Width of Inferior vena cava 2 centimetres, 3 centimetres and 4 centimetres above Iliocava junction measured.Width of right and left common iliac veins measured. (Illustration 2)

With the help of goniometer angle between two common iliac veins (Interiliac angle), angle between inferior vena cava and right common iliac vein(Right Iliocaval Angle), angle between inferior vena cava and left common iliac vein (left Iliocaval angle) measured(Illustration 3).

Distance between two common iliac veins at lower border of L5 vertebra was measured. Number of tributaries opening at iliocava junction and both common iliac veins noted.

Results

- The aortic bifurcation was situated between L3-L4 disc to L4 - L5 disc more frequently at the level of body of L4 i.e. 44.99%.
- The average height of the aortic bifurcation was 34 mm (± 8.87).
- The mean width of aortic bifurcation was 20.5 mm (± 2.16).
- Iliocava junction was on the right side and superior to the level of aortic bifurcation in all cadavers.
- The iliocava junction was situated between middle 1/3 of body of L4 to disc space between L5 and S1, and more frequently at disc space between L4 and L5 i.e. 41.66%.
- The average height of iliocava junction was 17 mm (± 6.49).
- The iliocava junction was always to the right side of sagital axis passing through the aortic bifurcation.
- The average distance between aortic bifurcation and iliocava junction was 26 mm (±4.96).

- The average width of inferior vena cava was maximum at the level of junction i.e. 28mm (±2.96). Width was found decreasing on measuring 2 centimeters to 4 centimeters successively.
- The average width of right common iliac vein was 20 mm (± 2.54)
- The average width of left common iliac vein was 19.7 mm (± 3.01). Thus no significant difference was found in width of right and left common iliac veins.
- The average interiliac angle was 72.5 degrees (± 9.07). 13. The average right iliocava angle was 162.5 degrees (± 7.18)
- The average left iliocava angle was 125 degrees (±11.81) .
- The average distance between two iliac veins measured at lower border of L5 was 43mm (±6.57).
- Average number of tributaries opening in left common iliac vein was 3 (± 0.41). Tributaries opening in IVC and right common iliac vein were 0-3.

Discussion

Area of formation of IVC by joining of two common iliac veins and bifurcation of abdominal aorta is of interest for radiologists and surgeons. Literature records many CT and MRI based studies of vascular anatomy inrelation to lumbar vertebrae.(3)

A study by Norio Kawahara , Katsuro Tomita and others in Kanazawa university Japan(38) concludes that vertebral tumors involving L3 and L4 can be approached by posterior *en bloc* spondylectomy but , for L4 , it is recommended to be done anteroposteriorly, mainly because of direct contact of IVC with vertebral column. Authors also recommend combined anterior and posterior approach for L5 tumor for anatomic complexity of major vessels at this level in addition to structural difficulty presented by iliac crest. Svein Anda and Svend Aakhus, neurosurgeons from Norway reports importance of detail knowledge of prevertebral lumbar vascular anatomy in a CT study done for evaluating vascular complications of anterior perforation discectomies. This study shows that IVC and common iliac veins have larger diameter and lie closer to the disc. They form broad vascular band especially at L4-L5 disc level. Therefore veins hit and punctured in anterior perforations.(4)

A cavographic study on infra renal segment of IVC by Bonnichon and Gaudard from Paris , France depicts diameter of IVC helps in caval filter placement. Thus it is clear that the trans peritoneal laparoscopic approach to the lumbosacral spine has become an increasingly common procedure both in spine surgery and in surgery of pelvic floor diseases. The iliocava junction and aortic bifurcation present the major limit to extensive exposure at this level.(5)

Radiological and cadaveric studies have related an important variability in the vascular structures adjacent to the lumbosacral spine. Site of aortic bifurcation is classically described at the level of L4 vertebral bodies. The aortic bifurcation occurs anywhere from body of L3 to L5. Present study has AB at L4 level in 44.99%. Similar study in cadavers by S. Pirro and D. Ciampi shows AB in 50% cases. By understanding limitations of study in cadavers, arteriographic, CT and MRI have recently been utilized for studying vascular anatomy AB. MRI study on 441 patients of lumbar vertebral disease at Michigen USA by M Chithriki and M Jaibaji(6)

reports 67% AB at L4 vertebra.

Table 1 : Comparison with Level of Aortic Bifurcation in Between M R I Study of M. Chithriki and M. Jaibaji and Present Study (6)

Vertebral Level	% of Patients in MRI Study	% of Cadavers in Present Study
Upper L3	0.9	-
Middle L3	1.4	-
Lower L3	7.0	-
L3-L4 disc space	13.4	28.33
Upper L4	19.1	20.00
Middle L4	24.0	1.66
Lower L4	23.8	23.33
L4-L5 disc space	7.7	26.66
Upper L5	1.6	-
Middle L5	0.9	-
Lower L5	0	-

This study also correlated incidence of vertebral anomalies like sacralisation and lumbarisation of vertebrae with level of AB. Study reports 8.4% cases with lumbosacral anomalies and states that location of the AB to be more cephlad in those with sacralisation and at a more caudal level in those with lumbarisation . In the present study there were no anomalies at the Lumbosacral junction. Lerona and Tewfik studied similar parameters in 100 pelvic arteriogram, but study was limited to females with pelvic malignancies. In same studies iliocava junction is more consistent in its location than aortic bifurcation.

The iliocava junction is related to L4-L5 disc level or to the L5 body level. Present study shows it at L4-L5 disc level in 41.33 % and at L5 body level in 48%, out of which 25% was found in lower third of the L5 body. Study by S. Pirro and D. Ciampishows 64% ICJ at L5 body. MR angiographic study by Jaume Capellaudes and Farran Pellisefocuses on vascular working window dependant on position of ICJ and Left Common Iliac Vein(CIV). This is important for anterior lumbar inter body fusion procedure. Study reports ICJ at L5 body level in 59.4 % cases. ICJ is reported at L5-S1 disc in 10% in MR angiographic study, 12% in study by S. Pirro and D. Ciampi and inonly one case in present study.

Only one radiological study, with 134 patients undergoing MRI for low lumbar pain by Jaume Capellaudes and Farran Pellise , has evaluated the position of the iliocava junction in relation to age and sex. Moreover this study included patients with spondylosis. Spondylosis and loss of disc height may contribute to the variability in vascular anatomy and modify relations between vessels and lumbosacral spine. The possibility of ethnic variations was mentioned.

The iliocava junction and the angle between two Common Iliac Veins (CIV) -interiliac angle determine the accessibility to the L5-S1 disc. The interiliac angle is as variable in anatomical studies as in radiological studies. The interiliac angle was found to depend on the height of iliocava junction in study of Jaume Capellaudes and Farran Pellise , which considered the iliac veins as having a constant endopelvic route between iliocava junction and other vascular structures. The vascular window located under iliocava junction between the two common iliac veins is main access to the L5-S1 disc. The height of iliocava junction and the position of left common iliac vein are the main predictive factors for anterior approach to L5-S1 disc. Same radiological study observed that the left common iliac vein was more medial in men than in women at L5-S1 disc. Two radiological studies show that vascular window is narrow in one third of the cases. However, the main criteria used in these studies for accessibility can not help in avoiding surgical complications. Only one retrospective study of KleemanTj and MicheilAhn U has compared iliocava convergence and the aortic bifurcation, evaluated by computed tomography with preoperative anatomy.(7)

With the development of cross-sectional imaging, anomalies of inferior vena cava have frequently been revealed on CT. These anomalies may be associated with widespread thrombosis of the iliac and femoral veins, particularly in young patients.

Gayer et al reports nine patients with an inferior vena cava anomaly who presented with widespread deep vein thrombosis of the pelvic and femoral veins. They studied first time this series of patients whose CT findings showed the uncommon association of congenital anomalies of the inferior vena cava with deep vein thrombosis.(3)

Anomalies of the inferior vena cava have been recognized as a possible risk factor for deep vein thrombosis, particularly in young adults, with only anecdotal CT descriptions. Ruggeri et al.found an anomalous inferior vena cava in four of 75 young patients with a first episode of deep vein thrombosis. Those authors estimated the prevalence of an anomalous inferior vena cava in that group of patients to be around 5.3%, but they assumed that their figures were necessarily conservative because some cases might have been missed by an incomplete radiology study or inadequate awareness of the possible causative relationship of an inferior vena cava anomaly with deep vein thrombosis. Obemosterer et al prospectively evaluated 31 patients with ileofemoral deep vein thrombosis on venography and MR angiography and found five with anomalies of the inferior vena cava. Authors also found a high prevalence (9.5%) of an anomalous inferior vena cava in young patients with deep vein thrombosis, instead of an expected rate of about 0.3% . The ideal imaging modality to help diagnose an IVC anomaly must have high diagnostic accuracy and also be safe and reproducible. It is difficult to establish a diagnosis of any IVC anomaly by ultrasound. Various clues are recognized on radiologic imaging that could help diagnose an absent IVC or anomaly. One of the more common and helpful clues is well developed and possibly dilated intrathoracic hemiazygous and/or azygous continuations. These collateral circulations as well as other retroperitoneal venous pathways are usually well developed before symptoms present.(8)

The most reliable, non-invasive methods to establish a diagnosis of IVC anomalies are CT with

intravenous contrast or magnetic resonance scan. CT scan, unlike ultrasound, is a good imaging modality of the retroperitoneal space. Another accurate, but more invasive, imaging modality is venography, which is particularly useful if any surgery is planned.

Illustration 1

Illustration showing measurement of height of aortic bifurcation

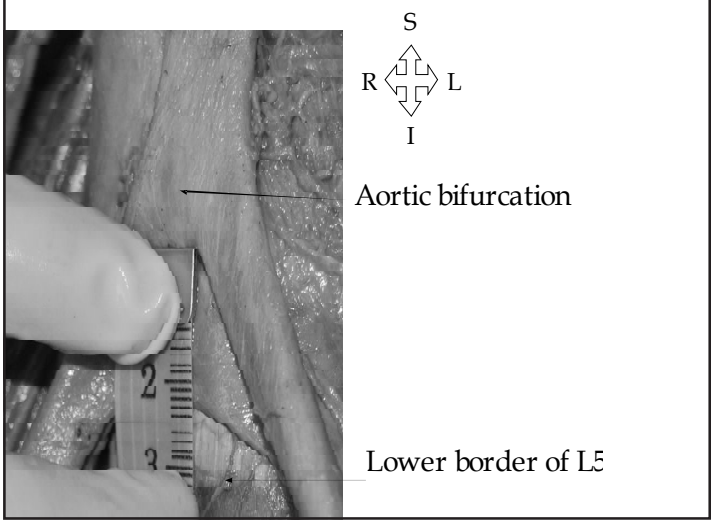
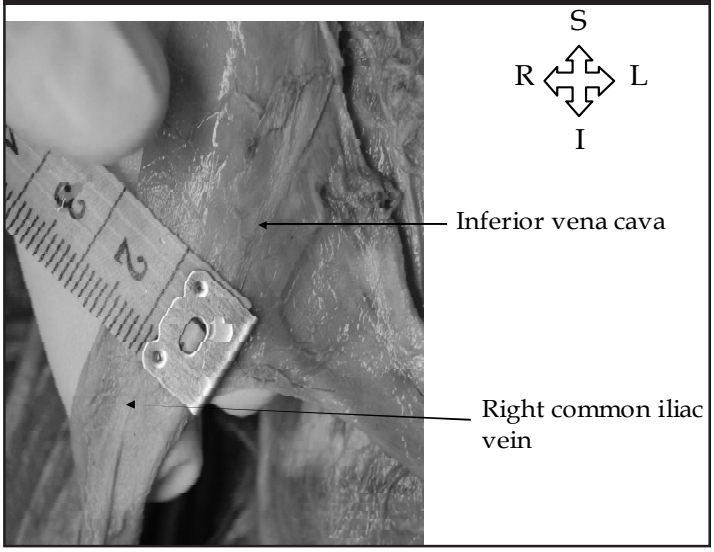


Illustration 2

Illustration showing measurement of width of right common iliacvein



It is hypothesized that blood return with an absent IVC is inadequate, despite adequate collaterals, resulting in chronic venous hypertension in the lower extremities and causing venous stasis that precipitates thrombosis.

Gayer et al recommended that all patients with an IVC anomaly be screened for a thrombophilic disorder. In their series, 7 of 9 patients with an IVC anomaly and DVT had a positive thrombophilic screen. There have been 3 case reports in the medical literature of thromboembolism due to an IVC anomaly (absence of the infrarenal portion of the IVC, infrarenal IVC hypoplasia). In all of these cases, the thrombophilic screen was negative. It was hypothesized that multiple emboli from DVT in the common and superficial femoral veins migrate through the well-developed hemiazygous and/or azygous system to the pulmonary circulation.

There is very little evidence available on the surgical correction or the treatment of this uncommon anomaly. A case report of a complete absence of the IVC but patent iliac veins and nonhealing pretibial ulceration described successful treatment with a prosthetic graft from the iliac vein to the intrathoracic azygous vein. Success was defined as complete healing of the ulcer up to 30 months after surgery.

Knowledge of the association of other anomalies in patients with an absent IVC, such as renal atrophy or agenesis, can highlight underlying vascular anomalies, which are in themselves of significant clinical importance. Clinician must have a profound awareness of the associated elements that make up the clinical complex of congenital vena caval abnormalities in order to avoid diagnostic and treatment pitfalls.

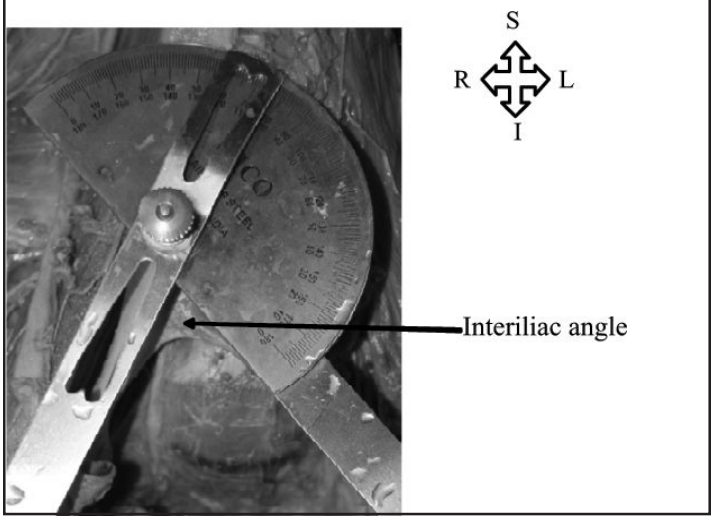
Conclusion

This study focuses on the anatomical relation of lower lumber spine with great vessels in abdomen. Anatomically they are placed in such a way that approach to lumber spine involves risk of vascular damage. So , as proven by various referred studies congenital anomalies specifically of formation of Inferior vena cava , and their respective relation with Aortic bifurcations plays crucial role in defining working window for surgery.

With the increased incidences of patients requiring surgeries for malignancies of vertebrae, spondylolisthesis, tuberculosis, vertebral body fusion, prior CT evaluation of vascular anatomy is advocated specifically when laparoscopic mode is planned.

Illustration 3

Illustration showing measurement of interiliac angle



This will also help in anticipating different medical conditions associated with various anomalies. It has importance in irradiation procedures too , which may be indicated for common gynaecological malignancies having high risk of vascular complication.

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