

Clinical Insight in Morphometric Analysis of Commencement of Inferior Epigastric Artery in Relation to Inguinal Ligament

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ABSTRACT

Introduction: The inferior epigastric artery usually arises from the external iliac artery just above the inguinal ligament. It may arise from different origin above or below the inguinal ligament.

Aim: The aim was to study origin of inferior epigastric artery in relation to inguinal ligament in males and females on both the sides.

Materials and Methods: The present prospective cross-sectional study was carried on 50 cadavers (30 male and 20 female). Three types of origin were observed- above, at the level or below the inguinal ligament. Distance of origin was measured above or below inguinal ligament with Vernier caliper. The observed data were analysed by calculating percentages of the normal and variant origins of inferior epigastric artery. The Z test of proportion was applied to compare the mean distance of origin of right and left inferior epigastric artery from the inguinal ligament and unpaired t-test to compare side wise variations and gender wise variations.

Results: In 100 specimens (50 cadavers) Inferior Epigastric Artery (IEA) arose mostly from External Iliac Artery (EIA) in 94 (94%) specimens, in 5 (5%) specimens from femoral artery and in 1 (1%)

from Internal Iliac Artery (IIA). In side wise comparison, 21 (42%) of right IEA and 26(52%) of left IEA originated above inguinal ligament with a mean distance of 17 mm and 20 mm respectively. 28 (56%) of right IEA and 20 (40%) of left IEA arose at the level of ligament. 1 (2%) of right IEA and 4 (8%) of left IEA originated below the inguinal ligament with a mean distance of 9 mm and 8.75 mm respectively. The above data is statistically insignificant ($p > 0.05$).

In gender wise study, in males 29 (48.33%) vessels originated above inguinal ligament, 29 (48.33%) at the ligament and 2 (3.33%) below the inguinal ligament.

In females 18 (45%) vessels originated above inguinal ligament, 19 (47.5%) at the ligament and 3 (7.5%) below the ligament. This is also statistically insignificant ($p > 0.05$).

Conclusion: Clinicians should be aware of variations in origin with reference to inguinal ligament, especially origin below the inguinal ligament prior to surgery such as hernia repair, use of IEA perforator flaps in breast/head neck reconstructive surgeries and even in interventional radiology.

Keywords: Embryological basis, Femoral artery, Hernia repair, Perforator flaps

INTRODUCTION

The Inferior Epigastric Artery (IEA) springs up commonly from external iliac artery just above the inguinal ligament. This artery runs superiorly in fascia transversalis to enter the rectus sheath beneath arcuate line. It anastomoses with superior epigastric artery [1]. The commencement of this artery is varying. It originates from the femoral artery below the inguinal ligament or from profunda femoris artery. It also has a high commencement from external iliac artery. Besides this, inferior epigastric artery arises as a common trunk with other arteries; circumflex iliac artery, obturator artery [2], obturator and medial circumflex femoral artery [3]. These common trunks arise from external iliac artery. There is a record of commencement of IEA originating from internal iliac artery via a common trunk with obturator artery [2].

IEA may be damaged during wide medial dissection of deep inguinal ring during hernia repair in preperitoneal plane [4]. The variability in origin and branching pattern of IEA has a high risk of haemorrhage in superior pubic fractures and inguinal or femoral hernias. Origin from femoral artery requires a special mention as many times femoral artery is a preferred vessel for angiography or catheterization [4]. Due to its surgical significance, origin, course, distribution and anomalies of IEA are of immense importance during transposition of rectus abdominis myocutaneous flap [5]. Awareness of the variations in anatomy of the inferior epigastric and femoral arteries is important for angiographers and the surgeons who operate in this region and has an important role in the successful surgical outcome [6].

Course: It curves forward in the sub peritoneal tissue and then ascends obliquely along the medial margin of deep inguinal ring,

continuing upwards it penetrates fascia transversalis and ascends between rectus abdominis and posterior lamella of rectus sheath. At its termination it splits into multiple branches which anastomose with branches of superior epigastric, a branch of internal thoracic artery and with lower intercostal arteries. As IEA runs superiorly, it forms infero-medial relation with deep inguinal ring. The vas deferens in males and round ligament of uterus in females turn around lateral and posterior aspect of IEA [7].

The present study was aimed to find out variations in commencement of IEA with reference to inguinal ligament.

MATERIALS AND METHODS

The present prospective, cross sectional study was carried out at Department of Anatomy, DY Patil Medical College, Kolhapur, Maharashtra, India from July 2014 to December 2017 on formalin embalmed cadavers used for undergraduate teaching. The cadavers were donated bodies received to the Institution and department under Bombay Anatomical Act. Ethical clearance was obtained from Institutional Ethical Committee, approval number DYPMCK/162/2018. Total 50 cadavers (total number of specimens 100) were dissected; 30 males and 20 females, between the age group of 50 to 80 years. Cadavers who had surgery or scar over lower abdominal wall, inguinal region and upper thigh region were excluded out from the study.

The dissections were performed in the area from the inguinal ligament to the upper part of the thigh. Origin of IEA was observed and traced with relation to the inguinal ligament both above and

below the ligament. Later during dislocation of hip joint sufficient stumps of neurovascular bundle were kept tracing origin of inferior epigastric artery behind inguinal ligament. Then, after identifying IEA, it was traced up to its entry into the rectus sheath. In case of high origin in pelvis, viscera were removed to locate the artery.

Following observations and measurements were done.

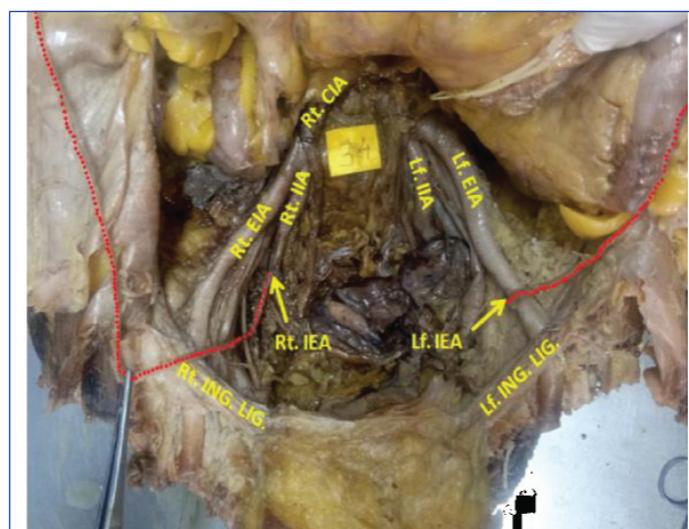
Commencement of inferior epigastric artery from external iliac artery or any other artery and its relation to inguinal ligament – at, above or below on both sides and in males and females were observed and noted. Distance of origin above or below inguinal ligament was measured with Vernier caliper in mm. All the observed data were entered in Excel worksheets (Microsoft Office Excel; version 2007) The data were analysed as percentages of normal and variant origins of IEA and Z-test of proportion was applied to compare the mean distance of origin of the right and left inferior epigastric artery above or below the inguinal ligament. Unpaired t-test was used to compare sidewise and gender wise variations.

RESULTS

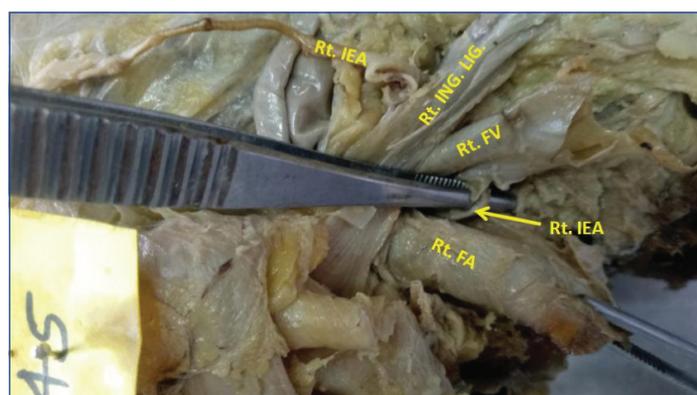
Out of 100 specimens, in 94 specimens IEA originated from external iliac artery, in five specimens from femoral artery and in one specimen from internal iliac artery [Table/ Fig-1-4].

	Above Ligament	At Ligament	Below Ligament
Right IEA (50)	21 (42%)	28 (56%)	1 (2%)
Left IEA (50)	26 (52%)	20 (40%)	4 (8%)
p value	0.31 NS	0.10 NS	0.16 NS

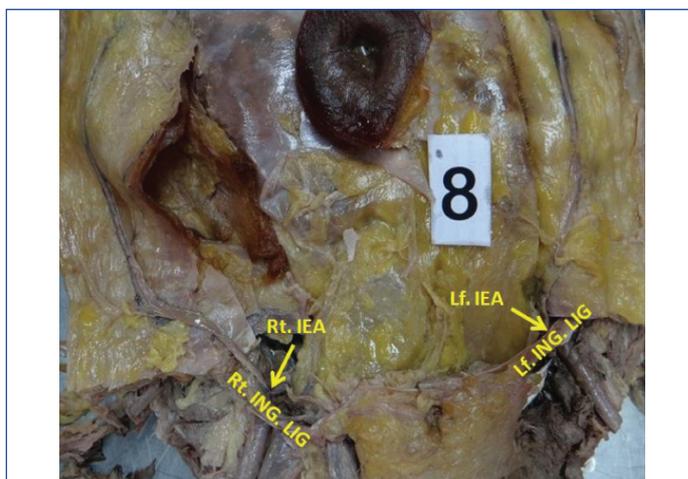
[Table/Fig-1]: Side wise commencement of IEA with relation to inguinal ligament. Z test: p> 0.05, Not Significant (NS); *IEA: Inferior Epigastric Artery



[Table/Fig-2]: Origin of IEA above inguinal ligament: Right IEA from internal iliac artery and left IEA from external iliac artery. *CIA: Common Iliac Artery; EIA: External Iliac Artery; IIA: Internal Iliac Artery; ING. LIG.: Inguinal Ligament



[Table/Fig-3]: Origin of Right IEA below inguinal ligament from femoral artery. *FA: Femoral Artery; FV: Femoral Vein



[Table/Fig-4]: Origin of right and left IEA at inguinal ligament.

It was observed that 21 (42%) right IEA and 28 (52%) left IEA originated above the inguinal ligament, 26 (56%) right IEA and 20 (40%) left IEA originated at the inguinal ligament while one (2%) Right IEA and four (8%) Left IEA originated below the inguinal ligament.

Gender wise origin of IEA shows that in 18(45%) females and 29(48.33%) males, IEA originated above inguinal ligament; in19(47.5%) females and 29(48.33%) males it originated at the ligament while in three (7.5%) females and two (3.33%) males, IEA originated below the inguinal ligament.

In case of right IEA, the mean distance of origin above the ligament was 17.88 mm while in case of left IEA it was 20.77 mm.

Right IEA originated with a mean distance of 9 mm below the inguinal ligament and left IEA at a mean distance of 8.75 mm below the ligament.

DISCUSSION

The anatomical variations of IEA are well reported. The inferior epigastric artery commonly arises from external iliac artery just above the inguinal ligament. Very high origin of IEA above the ligament from external iliac or internal iliac artery should be kept in mind during ligation of iliac vessels in pelvic surgeries. So also, origin below the ligament from femoral artery may have a risk of injury leading to unexpected haemorrhage during hip joint surgery, femoral hernia repair and psoas abscess drainage.

The IEA commences very often from external iliac artery in 88% and in 8% of cases found to be arising from femoral artery. Jakubowicz M et al., and Tanyeli E et al., described origin of IEA from proximal part of deep femoral artery [8,9]. AL Talalwah W et al., documented that inferior epigastric artery arose from external iliac artery in 83.6% independently and as a common trunk with obturator artery or aberrant obturator branch in 1.8% or 1.3% [10]. Sarikcioglu L et al., studied inferior epigastric artery in 54 specimens (25 male and 2 female) and reported that IEA originated from external iliac artery in 76.6% and from femoral artery in 22.2% [11]. In the present study, inferior epigastric artery arose from external iliac in 94% cases, from femoral artery in 5% cases and from internal iliac artery in 1% case [Table/Fig-1-3].

Bochenek A, et al., reported the origin of IEA to be above the level of inguinal ligament in 57% cases, at the level of the ligament in 28% cases and below the ligament in 15% cases he analysed [12]. Klepacki M, et al., reported that in group of 111 bodies investigated, 63 vessels originated above (41 males and 22 females), 31 at the level (27 males and 4 females) and 17 below the ligament (16 males and 1 female) [13]. Anandhi V et al., studied 50 specimens comprising 25 adult human cadavers in which the inferior epigastric artery was observed to arise above the inguinal ligament in 27 adult cases (54%) [14]. In the present study, 47 vessels originated above the ligament (18 females and 29 males), 48 at the ligament (19

females and 29 males) and 5 below the ligament (3 females and 2 males) [Table/Fig-1-5].

According to Worobiew origin of IEA above the ligament ranges from 5-10 mm. Luzsa states 5 mm above the ligament, Poirer states 8-10 mm above the ligament. Extreme high origin 20-30 mm is documented by Adachi and described by Testut [13]. In the present study IEA departed above the ligament in the range of 2 mm to 23 mm on right side and 2 mm to 30 mm on left side in males. In females the distance above the ligament ranged from 10 mm to 75 mm on right side and from 2 mm to 40 mm on left side [Table/Fig-6].

Lower origin changes the location of artery, which usually runs along femoral vein and enters abdominal cavity behind inguinal ligament [13]. Ercakmak, [6] also documented lower commencement of IEA – 13 mm inferior to ligament.

Sarikcioglu L et al., reported origin of IEA from femoral artery 0.8-1.6 mm below the inguinal ligament [11]. In the present study, five vessels originated below ligament from femoral artery at a mean distance of 9 mm. In one case, IEA passed behind femoral vein and inguinal ligament to enter the abdominal cavity [Table/Fig-1,3,6]. In many investigations including angiographies the femoral artery is mentioned as preferred and easily accessible to catheterisation. Knowledge about variations regarding variations in branches should be kept in mind and is important for clinicians in interventional radiology [4].

Side wise variation: On right side 21 arteries originated above inguinal ligament, 28 at the level of inguinal ligament and one below the inguinal ligament; while on the left side 26 arose above the ligament, 20 at the level of the ligament and four below the ligament [Table/Fig-1].

In case of right IEA, the mean distance of origin above the ligament was 17.88 mm while in case of left IEA it was 20.77 mm.

Right IEA originated with a mean distance of 9 mm below the inguinal ligament and Left IEA at a mean distance of 8.75 mm below the ligament [Table/Fig-6].

No comparable data for side wise variation was found.

Gender variation: In males, origin of Right IEA above the ligament was seen in 40%, at the level of ligament in 60% and below the ligament was not found; while in females, 45% was above the ligament, 50% at the ligament and 5% below the ligament [Table/Fig-5].

In males, origin of Left IEA above the ligament was seen in 56.66%, at the level of ligament in 36.66% and below the ligament in 6.66%, while in females, 45% was above the ligament, 45% at the ligament and 10% below the ligament [Table/Fig-5].

In males Right IEA originated with a mean distance of 11.66 mm above the inguinal ligament and in females at a mean distance of 24.11 mm while below the ligament with a mean distance of 9 mm in females [Table/Fig-6].

In males Left IEA originated with a mean distance of 18.11 mm above the inguinal ligament and in females at a mean distance of 23.44 mm while with a mean distance of 10 mm below the ligament in males and with a mean distance of 7.5 mm in females [Table/Fig-6]. No comparison data was found

Embryological Basis

Vascular diversity is generally a consequence of developmental aberration of the arterial plexus of the lower limb. The development of the vascular plexus of the lower limb is based on a peculiar choice of channels, some of which expand and the others constrict and evanesce, thereby setting the definitive pattern. Before pelvic and femoral arteries appear as separate blood vessels from the rete pelvicum and rete femorale respectively, the blood flow intended for this area makes an unanticipated selection of source channels. The commencement of inferior epigastric artery from femoral artery may be caused by such an unusual selection of channels [11]. The same we can reason for origin of IEA from internal iliac artery.

Clinical Significance

Commencement of IEA from the femoral artery changes the usual normal course of the artery and it runs posterior to the inguinal ligament to enter the abdominal cavity [13]. The commencement of IEA from femoral artery is rare. It may be injured during operations in the inguinal region. Such anomalous origin of IEA from femoral artery may cause unexpected haemorrhage during anterior approach to hip joint or drainage of psoas abscess [15].

Inferior epigastric skin flap (free-tissue skin) is used to repair defects following resection of ulcers and scar tissue on the head, neck and extremities. Viability of these flaps is dependent on the integrity of their blood supply following transposition or transplantation. Transposition of rectus abdominis myocutaneous flap into the groin may kink IEA leading to ischaemia of the transposed flap [11].

The variations in the commencement of IEA have a high risk of bleeding in superior pubic fractures and inguinal or femoral hernia repair [10].

In many investigations including angiographies the femoral artery is mentioned as preferred and easily accessible to catheterization. Knowledge about variations regarding variations in branches should be kept in mind and is important for clinicians in interventional radiology [4].

Sex	Right IEA (50)			Left IEA (50)		
	Above ligament	At ligament	Below ligament	Above ligament	At ligament	Below ligament
Female (20)	9 (45%)	10 (50%)	1 (5%)	9 (45%)	9 (45%)	2 (10%)
Male (30)	12 (40%)	18 (60%)	0	17 (56.66%)	11 (36.66%)	2 (6.66%)
p-value	0.72 N. S.	0.48 N. S.	0.21 N. S.	0.41 N. S.	0.56 N. S.	0.66 N. S.

[Table/Fig-5]: Gender wise commencement of IEA in relation to inguinal ligament. Unpaired t-test, p>0.05, Not Significant (NS)

	Rt. IEA (mm)						Lt. IEA (mm)					
	Male (30)		Female (20)		p-value	Total Mean (n=50)	Male (30)		Female (20)		p-value	Total Mean (n=50)
	Range	Mean+/-S. D	Range	Mean+/-S.D.			Range	Mean+/-S. D	Range	Mean+/-S.D.		
Above ligament	2-23	11.66+/-6.1	10-75	24.11+/-20.70	0.1	17.88	2 - 30	18.11+/-22.11	2 - 40	23.44+/-9.81	0.4	20.77
Below ligament	----	-----	9	9	Not possible	9	10	10	5 - 10	7.5+/- 3.53	Not possible	8.7

[Table/Fig-6]: Distance of Rt. and Lt. IEA in relation to inguinal ligament. Unpaired t-test, p>0.05, not significant

In case of pelvic angiography or ligation of internal iliac artery during surgical procedures, one should be aware of origin of IEA from Internal Iliac artery.

LIMITATION

This may be the first study to correlate side wise and gender wise variations in commencement of inferior epigastric artery with relation to inguinal ligament, hence no comparable data was found, and even large sample size may be needed.

CONCLUSION

The inferior epigastric artery is known to have variations in its origin. It may arise from femoral artery or internal iliac artery. Origin of IEA below the level of inguinal ligament is very rare and in this case, they climb to the abdomen behind inguinal ligament and sometimes may pass behind femoral vein and may be source of bleeding during surgical procedures in these regions. Inferior epigastric perforator flaps are used in breast reconstruction, head and neck reconstruction surgeries. It's relation with femoral ring and inguinal canal makes it vulnerable for injury. Femoral artery is preferred vessel for catheterization, keeping all these clinical implications, clinician should be aware of variations in anatomy of inferior epigastric artery.

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