

A STUDY OF THE ORIGIN AND COURSE OF THE INFERIOR EPIGASTRIC ARTERY AND ITS SIGNIFICANCE IN LAPAROSCOPIC SURGERY

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ABSTRACT

Background: The versatility of the inferior epigastric artery as a vascular graft in various areas and the recognition of its growing importance in the anterior abdominal wall and retroperitoneal region surgical disasters have all prompted me to study the inferior epigastric artery, with particular reference to the distance of the inferior epigastric artery from the important landmarks of the abdomen and pelvis. The results will prove to be a vital guide for the surgeons to select sites for trocar insertion to prevent fatal complications arising from injury to the inferior epigastric artery.

Materials and method: Study material consisted of 50 adult specimens from 16 male and 9 female cadavers studied by direct dissection method and predissectional dye injection method.

Results: Measurements were taken from the midline to the inferior epigastric artery at different levels of the anterior abdominal wall. The danger zones were delineated from the distances measured. Incisions and trocar insertions are to be avoided between 3cm and 8cm from the linea alba.

Conclusion: The distance of the inferior epigastric artery from the midline at various levels will provide a safe field to steer clear of the inferior epigastric artery while performing laparoscopic surgeries.

KEY WORDS: Inferior Epigastric Artery, Origin, Distance, Rectus Abdominis

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INTRODUCTION

During the last 15 years laparoscopic surgery has evolved from a rarely performed surgical venture to a routine procedure. The inferior epigastric artery is at risk of injury in laparoscopic surgeries during trocar insertion into the anterior abdominal wall where the artery and its branches lie.

The inferior epigastric artery or the deep inferior epigastric artery as it is usually referred to by surgeons, is found bilaterally in the anterior abdominal wall. It arises from the external iliac artery in the extra-peritoneal connective tissue just posterior to the inguinal ligament. It then ascends obliquely along the medial margin of the deep inguinal ring. Then it pierces the transversalis fascia and ascends

in front of the arcuate line and continues upward between the rectus abdominis muscle and the posterior lamina of its sheath. It divides into numerous branches which anastomose with those of the superior epigastric artery.

The branches of the inferior epigastric artery are cremasteric, pubic, muscular, cutaneous, peritoneal and anastomotic [1].

Of particular importance is the pubic branch which shows a great degree of variation and may become an abnormal obturator artery. This pubic branch anastomoses with the pubic branch of the obturator artery. This connection has been referred to as the corona mortis (crown of death). There is danger of laceration of the crown of death when blind dissection is done along the ilio-pectineal line.

Hence the study of the vascular anatomy of the inferior epigastric artery gains much importance.

MATERIALS AND METHODS

The inferior epigastric arteries in fifty specimens comprising 25 adult human cadavers (16 male and 9 female) preserved in formalin were studied. Of these, conventional dissection method was carried out in 40 specimens. Predissectional redoxide with bull's fat mixture injection was carried out in 10 specimens to study the branches of the inferior epigastric artery.

RESULTS AND FINDINGS

Distance of the origin of inferior epigastric artery above the inguinal ligament: The distance of the origin of the inferior epigastric arteries above the inguinal ligament was between 0.5 and 2 cm. The average distance was found to be 1.1 cm. (Fig.1)

Distance of the inferior epigastric artery from the important landmarks of the anterior abdominal wall: At the level of the umbilicus, the distance of the inferior epigastric artery from the midline varied from a minimum distance of 3.4 cm to a maximum distance of 4 cm on the right side and from a minimum distance of 3.2 cm to a maximum distance of 4 cm on the left side. Mean +SD was 3.6+0.2 cm on the right side, and 3.5+0.2cm on the left side. (Fig.2)

The distance of the inferior epigastric artery from midline from a point midway between the umbilicus and the pubic symphysis ranged between a minimum of 3.1 cm to a maximum distance of 4.2 cm on the right side. The minimum distance was 3 cm and the maximum distance 4.1 cm on the left side. Mean+SD was 3.5+0.4 cm on the right side and 3.4+0.3 cm on the left side. (Fig.3)

The distance of the inferior epigastric artery at its origin from midline just above pubic symphysis ranged between a minimum value of 3.5cm to a maximum value of 7.8 cm on the right side, and on the left side, the minimum value was 3.8 cm and the maximum was 8 cm. Mean+SD was 5.7+1.1 cm on the right side and 6.2+1.3 cm on the left side.(Fig.4)

Among the three levels the minimum distance was 3 cm and maximum distance was 8 cm.

The distance from the insertion of rectus tendon to the intersection of the inferior epigastric artery with the lateral rectus margin varied from a minimum distance of 3.4 cm and a maximum distance of 6.7 cm on the right, and minimum distance of 4.1 cm and a maximum distance of 7 cm on the left side. Mean+SD was 5+1.2 cm.

The average distance of the inferior epigastric artery from the midline at various levels have been compared with Alan Saber study in the graph. (Graph.1)

Fig. 1: Origin of Inferior epigastric artery 1cm above the inguinal ligament.



EIA-External iliac artery, IEA- Inferior epigastric artery, IL-Inguinal ligament

Graph 1: Showing the mapping of the inferior epigastric artery from the midline at three levels.

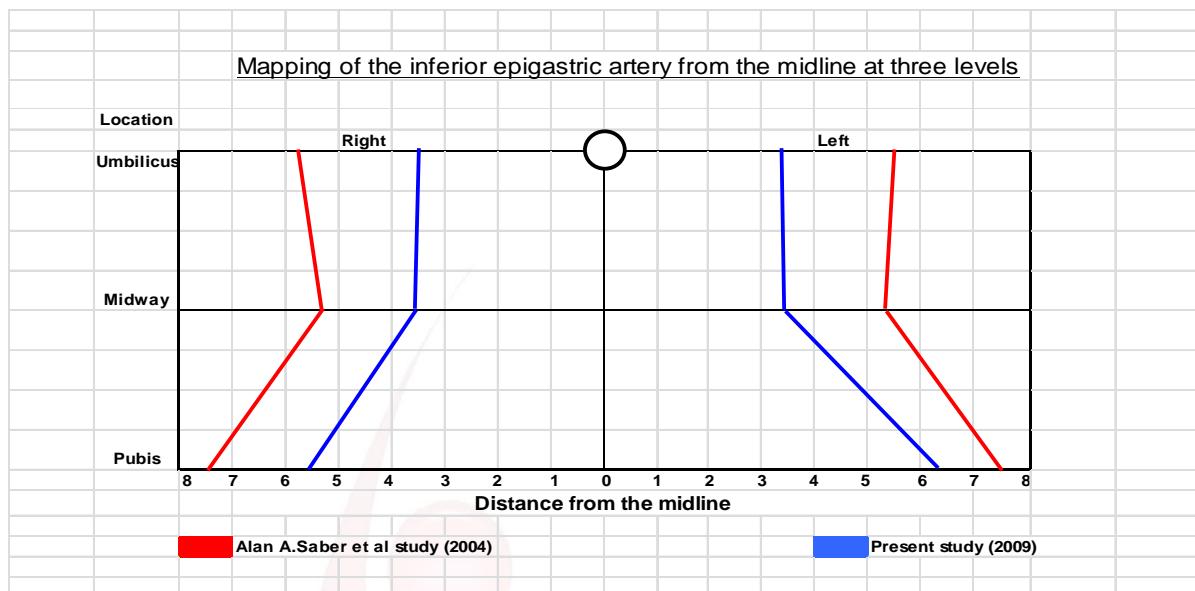
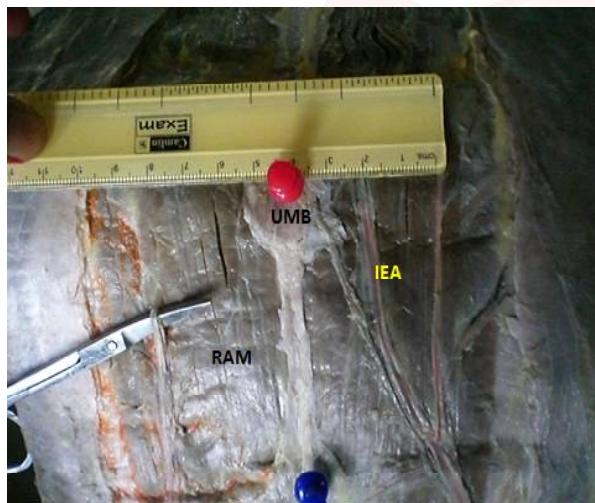
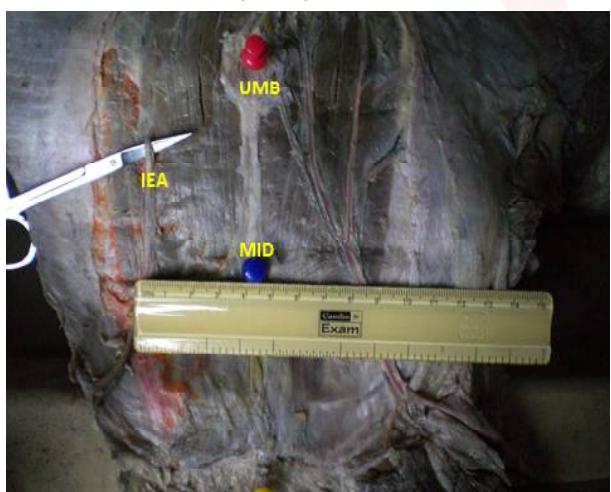


Fig. 2: Distance of inferior epigastric artery from midline at the level of umbilicus.



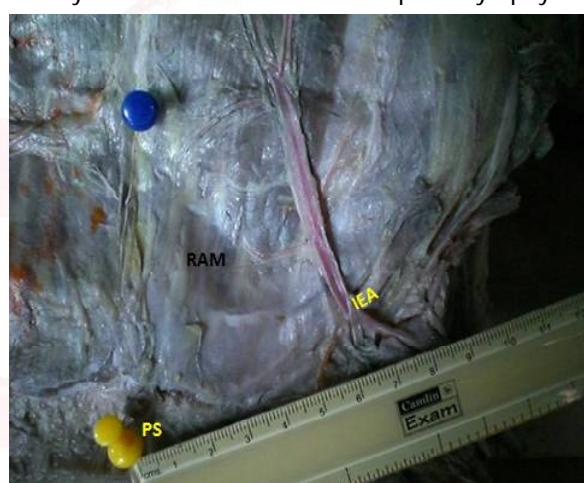
UMB- Umbilicus, RAM- Rectus Abdominis Muscle, IEA- Inferior epigastric artery.

Fig. 3: Distance of inferior epigastric artery from midline at the level of pubic symphysis.



PS- Pubic symphysis, RAM- Rectus Abdominis muscle, IEA- Inferior epigastric artery.

Fig. 4: Distance of Inferior epigastric artery from midline, midway between the umbilicus and pubic symphysis.



IEA- Inferior epigastric artery, MID- Midway between the umbilicus and pubic symphysis.

DISCUSSION

The site of origin of the inferior epigastric artery in relation to the inguinal ligament: Henry Gray (1858) [1] quoted that the inferior epigastric artery arises from the external iliac artery posterior to the inguinal ligament. R.J.Last (1954) [2] said that the inferior epigastric artery leaves the external iliac artery at the inguinal ligament.

In the present study, 23 adult specimens (46%) showed the inferior epigastric artery arising at the level of the inguinal ligament as described by the above authors. Morris (1893) [3] and John E. Skandalakis (2004) [4] have stated that the inferior epigastric artery arises just above the inguinal ligament. A.M.Buchanan (1906) [5] said

that the inferior epigastric artery arises $\frac{1}{4}$ inch above the inguinal ligament. Thomas Dwight et al (1907) [6] quoted that the inferior epigastric artery may arise from the external iliac artery higher up than usual as high as 6 cm (2 3/8 inch) above the inguinal ligament.

Sir John Bruce, R. Walmsley, J.A. Ross (1964) [7] said that the inferior epigastric artery arises from the external iliac artery about 0.5cm above the inguinal ligament.

Giovanni Teodori et al (1984) [8] stated that the origin of the epigastric may take place from any part of the external iliac artery between Poupart's ligament and 2 inches and a half above it.

Donald Serafin (1996) [9] noted that the deep inferior epigastric artery arises from the medial aspect of the external iliac artery, opposite the origin of the deep circumflex iliac artery approximately 1 cm above the inguinal ligament.

Michael S.Baggish and Mickey M. Karram (2001) [10] noted that the inferior epigastric artery takes its origin from external iliac vessels at a point cranial to the inguinal ligament.

Levent Sarikcioglu et al (2003) [11] reported that the inferior epigastric artery arose 1.2 -2.8 cm above the inguinal ligament.

In the present study the inferior epigastric artery was observed to arise above the inguinal ligament in 27 adult cases (54%). The distance of the inferior epigastric artery from the inguinal ligament was between 0.5-2cm, average 1.1cm, which coincides with the reports of A.M.Buchanan, Sir John Bruce et al, Donald Serafin, and Michael S. Baggish & Mickey M. Karram. (Table.1)

Table 1: Distance of the origin of the inferior epigastric artery above the inguinal ligament.

Authors	Distance (cm)
A.M.Buchanan 1906 [5]	1/4inch (0.625 cm)
Geovanni Teodori et al 1984 [8]	2 $\frac{1}{2}$ inch (6.25 cm)
Donald Serafin 1996 [9]	1 cm
Sir John Bruce et al 1964 [7]	1.2 -2.8 cm
Levent Sarikcioglu et al 2003 [11]	0.5 cm
Thomas Dwight 1907 [6]	2 3/8 inch (5.9 cm)
Present Study	0.5 - 2cm

Distance of the inferior epigastric artery from the important landmarks of the abdomen and pelvis: TeLinde Richard W (1894) [12] stated that lateral laparoscopic trocars are placed in a region of the lower abdomen where injury to the inferior epigastric and superficial epigastric vessels can occur easily. The inferior epigastric arteries and the superficial epigastric arteries run similar courses toward the umbilicus. Knowing the average location of these blood vessels helps in choosing insertion sites that will minimize their injury and the potential haemorrhage and hematomas that this injury can cause. Just above the pubic symphysis, the vessels lie approximately 5.5cm from the midline, whereas at the level of the umbilicus, they are 4.5cm from the midline.

Alan A.Saber et al (2004) [13] in a study of abdominal and pelvic CT images of 100 patients found that the average distance of the inferior epigastric artery from the midline at the umbilicus was 5.88 cm on the right and 5.55 cm on the left.

In the present study of 50 adult specimens the distance of the inferior epigastric artery from the midline at the level of the umbilicus was 3.5+0.4 cm on the right and 3.4+0.3 cm on the left, which is closer to the values of TeLinde Richard W.

Alan A.Saber et al (2004) found that the average distance of the inferior epigastric artery at the level midway between the umbilicus and the pubic symphysis was 5.32cm on the right and 5.25cm on the left.

In the present study of 50 adult cadaveric halves, the distance of the inferior epigastric artery from the midline at the level midway between the umbilicus and the pubic symphysis was 3.6+0.2 cm on the right and 3.5+0.2 cm on the left, which does not concur with the author.

Michael S.Baggish and Mickey M.Karram(2001) quoted that the distance from the midline (above the upper margin of the symphysis pubis) to the inferior epigastric vessels is 6 – 7 cm. Alan A.Saber et al (2004) found that the average distance of the inferior epigastric artery from the midline at the level just above the pubic symphysis was 7.47 cm and 7.49cm respectively on the right side and the left side.

In the present study of 50 adult specimens, the distance of the inferior epigastric artery from the midline at the level just above the pubic symphysis was $5.7+1.1$ cm on the right side and $6.2+1.3$ cm on the left side, which is similar to Michael S.Baggish and Mickey M.Karram(2001) values.

A.M.Buchanan(1906) proclaimed that the first part is indicated by a line from the medial border of the deep inguinal ring to the lateral border of the rectus abdominis at a point about midway between the umbilicus and the superior border of the pubic symphysis. The course of the second part (vertical) of the vessel is represented by a line corresponding with the centre of the rectus and about $1\frac{1}{2}$ inches from the linea alba. J.C.B.Grant (1937) [14] specified that the lateral border of the rectus is a nearly bloodless line, because very few branches of the epigastric arteries cross it and anastomose with the intercostal and lumbar arteries.

Hurd, William et al (1994) [15] testified that the inferior epigastric artery was $5.6+1.0$ cm from the midline.

In the present study of 50 adult specimens, the distance of the inferior epigastric artery from the midline ranged between 3 -8 cm similar to the above authors.

Frank J.Milloy,Barry J.Anson & David K McAfee (1960) [16] measured the distance from the insertion of the rectus tendon to the intersection of the inferior epigastric artery with the lateral rectus margin – the medial side of Hesselbach's triangle and found it to be 2-10cm.

In the present study of 50 adult specimens, the distance between the rectus tendon insertion and the intersection of the inferior epigastric artery into the lateral rectus margin was $5+1.2$ cm which concurs with Milloy et al study.

CONCLUSION

The inferior epigastric artery, the most important and largest blood vessel of the anterior abdominal wall, was studied in detail by conventional dissection and pre-dissectional dye injection methods. The observations of the study have been correlated with the findings of already existing studies. The following

conclusions are derived from the study.

The origin of the inferior epigastric artery is from the anteromedial surface of the external iliac artery bilaterally at or just above the inguinal ligament. The pubic branch of the inferior epigastric artery crosses the superior pubic ramus to anastomose with the pubic ramus of the obturator artery (corona mortis) where it is prone to injury in operations around the retropubic area like laparoscopic hernia repair. The distance of the inferior epigastric artery from the midline at various levels have been noted. Regardless of the abdominal level, the dangerous zone is found to be between 3 cm and 8 cm from the midline. Staying away from this area either medially or laterally will determine the safety zone of entry into the abdominal wall without risk of injury to the epigastric vessels during laparoscopic surgery.

A comprehensive study of the origin, branches, and distance of the inferior epigastric artery from important landmarks of the abdominal wall under a common umbrella will prove to be useful to the plastic surgeons who consider the lower abdomen skin and fat to be an ideal material for breast reconstruction, cardiothoracic surgeons evaluating the inferior epigastric artery as an alternative conduit for coronary artery bypass grafting, the laparoscopic surgeons and the general surgeons.

Conflicts of Interests: None

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