SURGICAL ANATOMY OF THE SUPERIOR EPIGASTRIC ARTERY

Hayder H. Abdul-Ameer[1] *FICMS,* **Akram A. Jaffar**[1] *Ph.D.*, **Hassan A. Hassan**[2] *FRCS*

Abstract:

Background: The superior epigastric artery and its preservation during surgical procedures are now gaining more importance. Anatomical studies regarding variations in the epigastric vessels have not been conclusively reported. More emphasis was directed towards the inferior epigastric artery on the expense of its superior counterpart.

Objective: To illustrate the gross anatomy of the superior epigastric artery with special emphasis on laparoscopic cholecystectomy entry sites in order to map a safety zone.

Method: Fifteen embalmed cadavers were dissected. Complications pertaining to the superior epigastric artery were reviewed in 90 patients who underwent laparoscopic cholecystectomy.

Results: Gross arterial communication between the superior and inferior epigastric arteries was observed in (33%) of the cadavers where it was located above the umbilicus. In the epigastric region, the main stem of the superior epigastric artery was located within a longitude not extending laterally away from 5 cm off the midline. The inferior epigastric artery was commonly larger than the superior. In only one cadaver (7%) the caliber of the superior epigastric artery was comparable to that of the inferior. In (4.4%) of the cholecystectomy cases, bleeding occurred when the laparoscopic port was extended laterally beyond the 10-12mm wide incision at the point 5cm inferior to the xiphisternum.

Conclusion: A variably large superior epigastric artery should be kept in mind during surgical interventions; the absence of accompanying arterial anomalies indicated that the large size of the artery is a normal anatomical variation. In the epigastric region, a safety zone could be determined lateral to 5cm off the midline. In laparoscopic cholecystectomy, the port incision in the epigastric region should not be extended laterally beyond 12mm off the midline. If circumstances dictate then the port should be enlarged using a dilator.

Key words: Superior epigastric artery, anatomical variation, laparoscopic cholecystectomy

IRAQI J MED SCI, 2006; VOL. 5 (1): 3-7

Introduction

The superior epigastric artery is a terminal branch of the internal thoracic (mammary) artery. According to some, it passes through a space limited medially by the sternal part of the diaphragm, laterally by the costal part of the diaphragm, and anteriorly by the musculoaponeurotic plane formed by transversus thoracis and transversus abdominis (Larrey"s space or trigonum sternocostale), therefore through a diaphragmatic orifice[1]. According to others it passes in front of the diaphragm, anterior to transversus thoracis and transversus abdominis and thus in front of the musculoaponeurotic plane[2].

Entering the rectus sheath, at first behind the rectus abdominis muscle and then perforating and supplying it. The superior epigastric artery usually anastomoses with the inferior epigastric branch of the external iliac artery. Branches perforate the sheath to supply the abdominal skin. The artery supplies the diaphragm; on the right small branches reach the falciform ligament to anastomose with the hepatic artery[3]. A xiphoid branch contributes to the supply to

[1]Dept. Human Anatomy, [2]Dept. Surgery, College of Medicine, Al-Nahrain University

Received 18th October 2005: Accepted 12th February 2006.

Address Correspondence to Dr. Akram A. Jaffar, Email: akramjfr@yahoo.com**, Website:** http://www.geocities.com/akramjfr**, Mobile 00964-7901-308789**

the lower sternal region and may be of special importance when used as a conduit in coronary artery by-pass grafts[4]. At the intersections of the rectus abdominis muscle there are transverse arcades arising from either the superior or inferior epigastric arteries, which send branches supplying muscle or the overlying skin[5].

The epigastric arterial "system" is of considerable interest because of the grossly demonstrable direct arterial communication between the superior epigastric and the inferior epigastric arteries in 40% of a series of cadaver dissections. In atherosclerotic occlusion of the common iliac artery this must certainly be one of the important collateral pathways for blood to reach the ischemic extremity[6].

Anatomical studies regarding variations in the epigastric "system" of vessels have not been conclusively reported. More emphasis was directed towards the inferior epigastric artery on the expense of its superior counterpart[7-9]. This study aims at illustrating the anatomy of the superior epigastric artery relative to common surgical incisions and laparoscopic entry sites on the anterior abdominal wall in order to map a safety zone.

Methods

Fifteen embalmed adult cadavers (originally used for teaching purposes at the Department of Human Anatomy, College of Medicine, Al-Nahrain University) were dissected for the contents of the rectus sheath with emphasis on the epigastric vessels. The basic procedures for dissection were based on the method outlined in Sauerland[10].

The origin, course, and the distance from the midline of the superior epigastric artery were noted. The site and mode of anastomosis between superior and inferior epigastric arteries were clarified by tying a cannula at either end of the epigastric arterial "system": internal thoracic or inferior epigastric arteries. Tap water was pushed through this cannula till the vascular anastomosis became clear.

Complications pertaining to the superior epigastric artery were reviewed in 90 patients who underwent laparoscopic cholecystectomy by using the American technique at Al-Kadhmiya Teaching Hospital. The latter implies a puncture site 5cm inferior to the xiphoid process. At that point, a transverse incision about 10-12mm was made for the insertion of the laparoscopic port.

Results

The superior epigastric artery was seen on dorsal surface of the rectus abdominis muscle in all the cadavers (Fig.1). Gross arterial communication between the superior and inferior epigastric arteries was observed in 5 (33%) of the cadavers dissected. The anastomosis between the inferior and superior epigastric arteries was located at a level above the umbilicus in all the cadavers. In the epigastric region, the main stem of the superior epigastric artery was located within a longitude not extending laterally away from 5 cm off the midline. No discrepancy was observed on both sides of the body regarding the origin, course, anastomosis, and caliber of the superior epigastric arteries.

The inferior epigastric artery is larger than the superior epigastric artery in 14 cadavers (93%). In only one cadaver (7%) the caliber of the superior epigastric artery was equal in size to that of the inferior epigastric artery (Fig.2). This unusually large superior epigastric artery was observed on both sides of the body and was not accompanied by any arterial anomaly elsewhere in the trunk. The accompanying inferior epigastric artery was neither atrophied nor has an unusual course or origin.

Out of 90 surgical cases only 4 (4.4%) had bleeding when the laparoscopic port was extended laterally beyond the 10-12mm wide incision at the point 5cm inferior to the xiphisternum. In one of the four cases, the

bleeding was to the inside the rectus sheath. In the cases when the port was enlarged by using a dilator no such bleeding occurred.

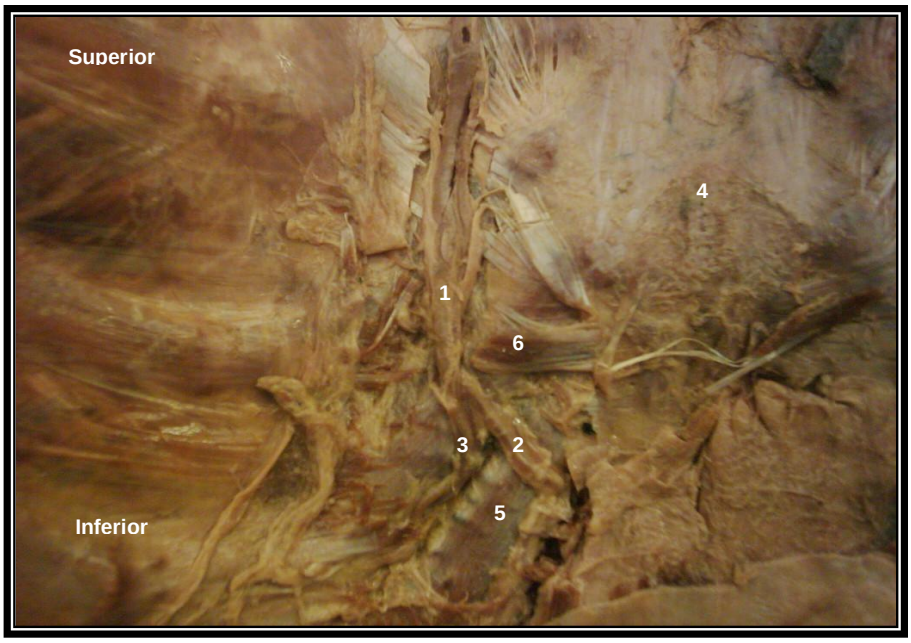

Fig.1: Posterior aspect of the anterior thoraco-abdominal wall showing the terminal branches of the internal thoracic artery at the left 6th intercostal space. 1: internal thoracic artery, 2: superior epigastric artery, 3: musculophrenic artery, 4: back of the sternum, 5: back of the 7th costal cartilage, 6: transverses thoracis.

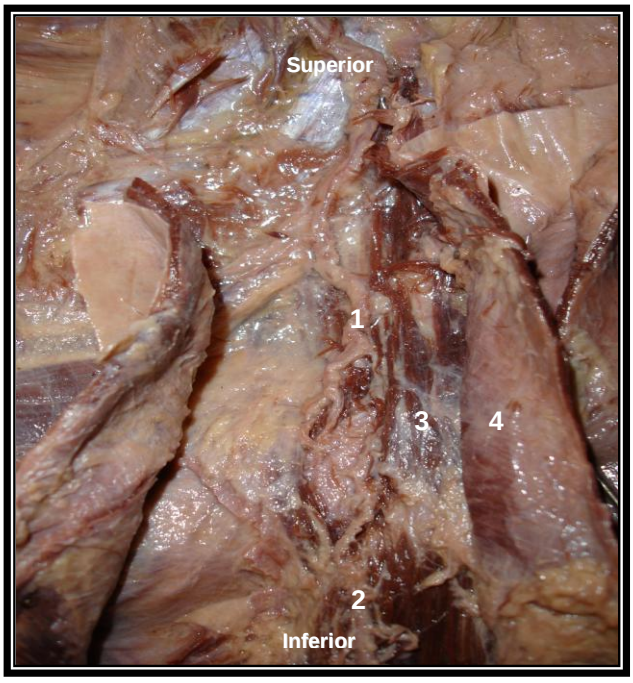

Fig.2: The epigastric arterial "system" on the dorsal aspect of the rectus abdominis muscle. Note that the superior and inferior epigastric arteries are of comparable caliber. 1: superior epigastric artery, 2: inferior epigastric artery, 3: rectus abdominis muscle, 4: posterior wall of the rectus sheath reflected medially.

Discussion

The superior epigastric artery and its preservation during surgical procedures involving anterior abdominal wall is now gaining more importance in view of its significance in planning muscle-flap reconstructive surgery[11-14] its possible insult in laparoscopic procedures, its role in establishing a collateral circulation following aortico-iliac occlusions[15], and the possible sequels of its injury on wound healing after surgery[16,17].

The feasibility and the safety of endoscopic cholecystectomy for symptomatic cholecystitis are widely accepted. Cosmetic advantages are evident and are important in young woman. Endoscopic abdominal surgery also reduces postoperative intestinal and parietal adhesions. Overall this surgical procedure provides a very simple postoperative course with reduction of pain and rapid recovery of abdominal transit[18].

In this study, the superior epigastric artery was seen on dorsal surface of rectus abdominis muscles in all the cadavers; however it should be noted that when the artery is not seen in its commonest location, it may either be absent or buried in the muscle tissue. In a very rare occasion (0.6%) did the superior and inferior epigastric arteries anastomose on the anterior surface of the rectus muscle[6].

The frequency of a gross arterial communication between the superior and inferior epigastric arteries as observed in the cadavers dissected in this study (33%) is closely related to the 40% occurrence observed elsewhere[19]. The location of the anastomosis at a level above the umbilicus coincides with the observation of O'Dey et al.[20].

The inferior epigastric artery is usually larger in diameter than the superior epigastric artery[21]; this was mostly observed in this study as well. Only in one case (7%) in this study, the superior and inferior epigastric arteries were comparable in size. The absence of accompanying arterial anomalies indicates that the larger size of the artery is normal anatomical variation and is not a compensatory sequel of a pathological obstruction of the normal conduits. This variation should be born in mind as it may be the source of considerable bleeding should the artery be injured during surgery.

In the epigastric region, the location of the superior epigastric artery within a longitude not extending away from 5cm off the midline could determine the safe zone of entry of the anterior abdominal wall at this region. The location of the artery within this limit is closely related to the mapping study of Saber et al.[22] Damage to the superior epigastric artery intraoperatively resulting in a rectus sheath hematoma has been reported as an early consequence of percutaneous endoscopic gastrostomy[23]. In planning laparoscopic cholecystectomy, the incision of the laparoscopic port should not be extended laterally beyond 12mm off the midline lest considerable bleeding would be faced. If circumstances dictate, as when extracting a gall bladder with a large stone impacted inside, then the port should be enlarged using a dilator. Preservation of the superior epigastric artery not only could avoid a serious bleeding during the operation but also decreases the inflammatory reaction and formation of scar[16].

In the one case of bleeding inside the rectus sheath, injury may have involved the main stem of superior epigastric artery. In the other three cases where bleeding was to the outside of the rectus sheath, injury may have involved a branch of the superior epigastric or a collateral branch of an intercostal artery.

References

1. Standring S (chief editor): Gray's anatomy: the anatomical basis of clinical practice. 39th ed. Elsevier. Edingburg, 2005; p.p. 1101.
2. Baudoin YP, Hoch M, Protin XM, Otton BJ, Ginon B, and Voiglio EJ: The superior epigastric artery

does not pass through Larrey's space (trigonum sternocostale). Surg Rad Anat, 2003; 25: 259-62.
3. Williams PL, Warwick R, Dyson M, and Bannister LH: Gray's anatomy. 37th ed. Churchill Livingstone. Edinburgh, 1995; p.p. 755.
4. Lachman N and Satyapal KS: Origin and incidence of xiphoid branch of the internal thoracic artery. Surg Radiol Anat, 1999; 21: 351-4.
5. Whetzel TP and Huang V: The Vascular Anatomy of the Tendinous Intersections of the Rectus Abdominis Muscle. Plas Recon Surg,1996; 98: 83-9.
6. Milloy FJ, Anson BJ, and McAffee DK: The rectus abdominis muscle and the epigastric arterias. Surg Gynecol Obstet, 1960; 110: 293-302.
7. Balzer KM, Witte H, Recknagel S, Kozianka J, and Waleczek H: Anatomic guidelines for the prevention of abdominal wall hematoma induced by trocar placement. Surg Radiol Anat, 1999; 21: 87-9.
8. Buche M and Dion R: Current status of the inferior epigastric artery. Semin Thorac Cardiovasc Surg, 1996; 8:10-4.
9. Epstein J, Arora A, and Ellis H: Surface anatomy of the inferior epigastric artery in relation to laparoscopic injury. Clin Anat, 2004; 17: 400-8.
10. Sauerland EK: Grant's dissector. 9th ed. Williams & Wlkins, 1984; p.p. 28-30.
11. Xing-Quan Z, Shao-Dong W, Qing-Yu F, and Bao-An M: Versatility of rectus abdominis free flap for reconstruction of soft-tissue defects in extremities. Microsurgery, 2004; 24:128-33.
12. Pacifici A, Cirocchi R, Dominici MM, Flamini FO, and Dominici C: Anatomo-clinical study of rectus abdominis myocutaneous flap. Minerva Chir, 1997; 52: 1271-5.
13. Canales FL, Furnas H, Glafkides M, Davis JW Jr, and Lineaweaver WC: Microsurgical transfer of the rectus abdominis muscle using the superior epigastric vessels. Ann Plast Surg, 1990; 24: 534-7.
14. Moon HK and Taylor GI: The vascular anatomy of rectus abdominis musculocutaneous flaps based on the deep superior epigastric system. Plast Reconstr Surg, 1988; 82: 815-32.
15. Kim J, Yun Won J, Park S, and Yun Lee D: Internal Thoracic Artery Collateral to the External Iliac Artery in Chronic Aortoiliac Occlusive Disease. Korean J Radiol, 2003; 4: 179-83.
16. Liu T, Dai S, and Wei M: The clinical significance of preserving superior epigastric vessels in Cohen incision. Zhonghua Fu Chan Ke Za Zh, 1999; 34: 401-2.
17. Schwartz DS, Petrossian E, Brodman RF, Frame R, Schwartz JD, Blitz A, et al: Wound healing after harvesting of the internal thoracic and the superior and inferior epigastric arteries. Ann Thorac Surg, 1994; 57: 1252-5.
18. Dubois F, Icard P, Berthelot G, and Levard H: Coelioscopic sholycystectomy preliminary report of 36 cases. Ann Surg, 1990; 211: 60-2.
19. Bergman RA, Afifi AK, and Miyauchi R: Illustrated Encyclopedia of Human Anatomic Variation: Opus II: Cardiovascular System: Arteries: Pelvis, Inferior and Superior Epigastric Arteries. Anatomy atlases, a digital library of anatomy information. ©1995-2006. [homepage on the internet] [Cited: 2006 January 30] [about 2 pages] Available from: http://www.anatomyatlases.org/AnatomicVariants/Cardiovascular/Text/Arteries/EpigastricInferiorSuperior.shtml .
20. O'Dey DM, Heimburg DV, Prescher A, and Pallua N: The arterial vascularisation of the abdominal wall with special regard to the umbilicus. Br J Plas Surg, 2004; 57: 392-7.
21. Vokurka J and Vokurkov J: Bleeding from an umbilical port can be prevented: case report. Scripta Medica (Brno), 2004; 77: 21–4.
22. Saber AA, Meslemani AM, Davis R, and Pimentel R: Safety zones for anterior abdominal wall entry during laparoscopy: a CT scan mapping of epigastric vessels. Ann Surg, 2004; 239: 182-5.
23. Ubogu EE and Zaidat OO: Rectus Sheath Hematoma Complicating Percutaneous Endoscopic Gastrostomy. Surg Lap Endos Precut Tech, 2002; 12: 430-2.