The Journal of Chulabhorn Royal Academy
eISSN : 3027-7418 (Online)

Academic article

Mapping Inferior Epigastric Artery Relative to Abdominal Landmarks: Defining Surgical Safe Zones and Risks

Perawat Garunyapakun[1]*, Sirorat Janta[1], Gaewarin Liamvilairat[2], Phetnarin Kobutree[1]

[1]Anatomy Unit, Department of Medical Sciences, Faculty of Science, Rangsit University
[2]Department of Basic Medical Sciences, Faculty of Medicine, Siam University

*Corresponding Author, e-mail: perawat.g@rsu.ac.th

Received: 15 June 2025; Revised: 14 January 2026; Accepted: 27 January 2026

Abstact

The inferior epigastric artery (IEA) is a critical landmark during laparoscopic surgery. While IEA injuries occur in only up to 2% of procedures, they can lead to serious complications such as port-site hematomas or life-threatening hemorrhage. This systematic review aims to clarify the IEA's anatomical course relative to key abdominal landmarks to define surgical safe zones. We synthesized data from cadaveric dissections, radiologic imaging (CT and ultrasound), and surgical anatomy reviews. The IEA consistently courses within a paramedian "danger zone," typically located 4-8 cm lateral to the midline. Variations exist based on population and side; for instance, some studies show the vessel as close as 2 cm or as far as 10 cm from the midline. Higher BMI also tends to push the IEA slightly more lateral. To minimize injury risk, trocars should be placed in identified "safe zones": the avascular midline (linea alba) or areas >8 cm lateral to the midline. Given the current lack of Thai-specific anatomical data, local cadaveric studies are essential to refine these safety guidelines for regional populations.

Keywords: Inferior epigastric artery, Laparoscopic surgery, Trocar placement, Cadaver

Introduction

The inferior epigastric artery (IEA), a branch of the external iliac artery, runs obliquely along the inner abdominal wall to supply the rectus abdominis and anastomoses with the superior epigastric artery near the costal margin.[1,2] This vessel's course places it at risk during laparoscopic port placements, especially in the lower abdomen. IEA injuries during trocar insertion are uncommon but have been reported in up to 2% of laparoscopic procedures.[3,4] Such injuries may cause complications ranging from port-site hematomas to life-threatening hemorrhage. Therefore, understanding the IEA's surface anatomy in relation to key landmarks is crucial for surgical safety.

This review summarizes studies on the IEA's anatomical relationship to key anterior abdominal wall landmarks, including the pubic symphysis, xiphoid process, costal margin, anterior superior iliac spine (ASIS), and umbilicus. We review findings from cadaveric dissections, radiologic imaging, surgical anatomy reviews, and clinical case reports. In particular, we highlight defined 'safe zones' for trocar placement and identify high-risk regions to avoid. Where available, data from Asian populations are emphasized. In the absence of Thai-specific studies, we draw on findings from other populations and highlight gaps for future research. Key results are presented by source type, emphasizing the IEA's relationship to landmarks and its implications

for laparoscopic safety. These relationships and the recommended safe zones for trocar placement are summarized in Table 1 and Figure 1.

Table 1 Summary of inferior epigastric artery (IEA) location relative to anatomical landmarks and recommended "safe zones" for trocar insertion

Study Type	Population	Landmarks	IEA Distance	Safe Zone	Reference
Cadaveric	Western	Midline to ASIS	3-8 cm (Mean ~5 cm)	Midline (linea alba) or >8 cm lateral	5,6
Cadaveric	Indian	ASIS, Umbilicus	4.10-4.49 cm	>5.5 cm lateral from midline	7
Radiologic (US)	Chinese	Midline, Pubis	4-8 cm lateral band	~7 cm lateral and ~5 cm above pubis	8
Radiologic (US)	Uygur	Pubis, ASIS	3.5-8 cm (R < L)	Avoid 3.5–8 cm from midline	9
Radiologic (CT)	USA	Xiphoid to Pubis	4.4-7.5 cm	<4 cm (medial) or >8 cm (lateral)	10

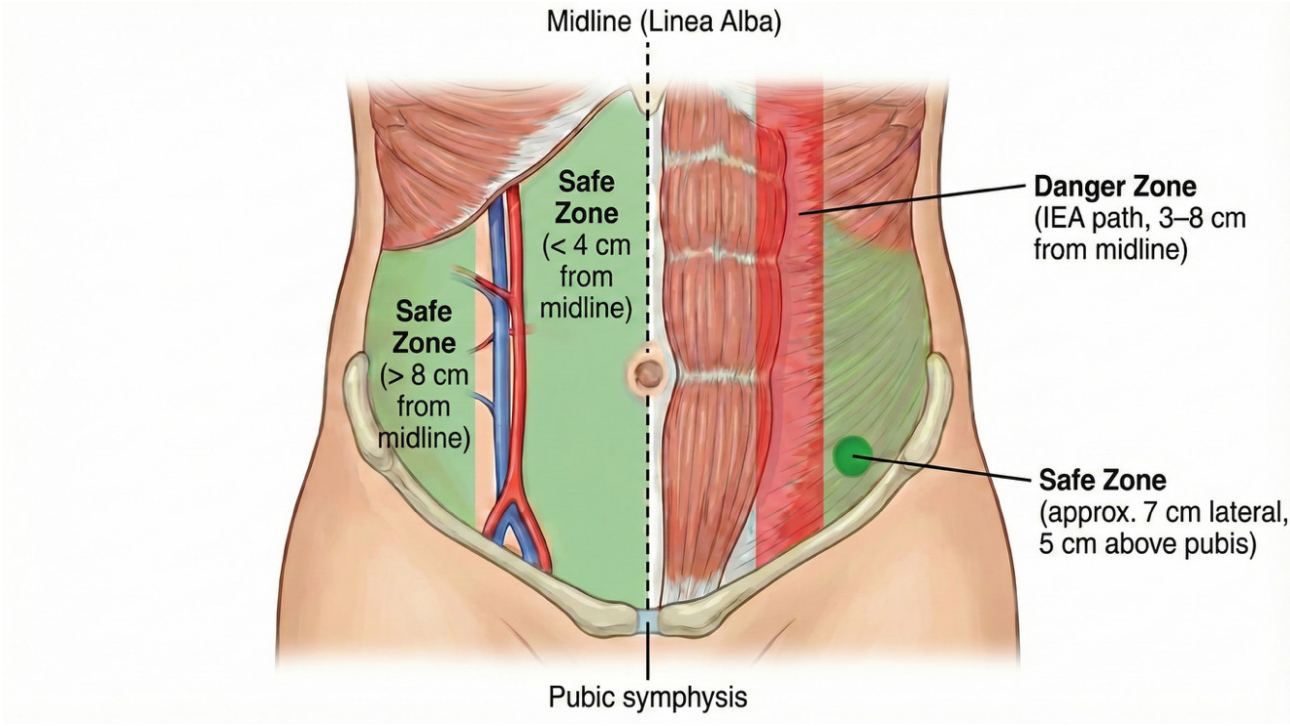

Figure 1 Schematic diagram illustrating the anatomical position of the inferior epigastric vessels and defined zones for safe trocar insertion in the lower anterior abdomen.

The illustration presents an anterior view centered on the midline (linea alba). The left half depicts the rectus abdominis muscle intact, covering the course of the inferior epigastric artery and vein. The right half shows the rectus abdominis muscle removed to reveal these vessels (indicated by arrows) running vertically

on the posterior sheath. The red shaded area labeled "Danger Zone" (approximately 3-8 cm lateral to the midline) indicates the typical location of the inferior epigastric vessels, representing a high risk for vascular injury. Green shaded areas labeled "Safe Zone" denote regions considered to have a lower risk for trocar placement, located medially (< 4 cm from the midline) and laterally (> 8 cm from the midline, with an additional specific safe spot noted approximately 7 cm. lateral). Key anatomical landmarks shown include the umbilicus, pubic symphysis, and anterior superior iliac spine (ASIS).

Cadaveric Anatomy Studies

Cadaveric dissections have provided important baseline information on the course of the inferior epigastric artery (IEA) in relation to the midline and bony landmarks, while also highlighting substantial interindividual and side-to-side variability. Across cadaveric studies, the IEA typically lies 4-8 cm from the midline, although rare cases have shown the artery coursing as close as ~2 cm or as far as ~10 cm laterally.[11,12]

A dissection study of fresh Indian cadavers demonstrated that the IEA generally follows a paramedian course from its pubic origin toward the umbilicus, with greater lateral dispersion at higher abdominal levels.[11] In some specimens, the artery terminated below the umbilicus, emphasizing variability in vessel length. The left IEA tended to lie slightly more medially than the right in the lower abdomen. Based on these observations, the authors described a paramedian “danger zone” beneath the abdominal wall corresponding to the typical trajectory of the IEA and noted that its width increases toward the umbilical level.[12,13] Similar findings were reported in cadaveric surface-mapping studies in Western populations, which consistently identified the IEA danger zone within the paramedian region.[5,6] These studies confirmed that the linea alba is reliably avascular, whereas the region lateral to the rectus abdominis muscle lies beyond the usual course of the epigastric vessels. Other cadaver-based analyses focusing on minimally invasive surgery proposed practical safety margins, suggesting that trocar placement at approximately 5-6 cm or more from the midline avoids the typical path of the IEA.[7,14]

To reduce the risk of inferior epigastric vessel injury, laparoscopic ports should be placed either at the midline (linea alba) or more than ~8 cm lateral to the midline, thereby avoiding the paramedian IEA danger zone.

This aligns with the idea that roughly a 5-6 cm clearance from midline laterally is needed to be outside the typical trajectory of the inferior epigastric vessels. Notably, this distance is similar to the lateral edge of the rectus sheath in many individuals, reinforcing that ports just outside the rectus muscle are safer. The authors also stressed that the umbilical region is relatively avascular centrally, making it a common and safe primary entry point, whereas lateral ports require careful placement to avoid the epigastric field.[3,6]

Although these principles appear consistent across populations, region-specific cadaveric data remain limited, and further anatomic studies in Asian populations, including Thai cohorts, are warranted.[2,15]

Imaging-Based Mapping Studies

CT angiography and ultrasonography have mapped the inferior epigastric artery (IEA) in living subjects, largely corroborating cadaveric findings while providing population-specific and dynamic information. Collectively, CT and ultrasound studies confirm that the IEA most commonly courses within a paramedian danger zone approximately 4-8 cm lateral to the midline in the lower abdomen.[9,10,11,18]

A landmark CT study mapping the deep epigastric vessels in vivo demonstrated that, across multiple horizontal levels from the xiphoid to the pubic symphysis, the epigastric vessels consistently remained within this paramedian band.[10,11] Based on these findings, the authors recommended that when internal landmarks are unclear, lateral trocars should be placed at least ~8 cm lateral to the midline and ≥5 cm above the pubic symphysis to minimize the risk of vascular injury.[10,16] These practical coordinates have since been widely adopted as surgical guidelines.

CT angiography studies further refined these safety margins by accounting for interindividual variability, proposing “security distances” that extend slightly farther laterally at higher abdominal levels,

particularly near the umbilicus.[18] Overall, these data emphasize that secondary ports placed near the umbilical horizontal plane may require a wider lateral offset to reliably avoid the IEA.

Ultrasonographic studies have highlighted potential population and side-specific differences in IEA course. For example, a study in patients of Uygur ethnicity demonstrated consistent left-right asymmetry, with the left IEA running more laterally than the right at multiple levels.[9] Rather than detailing these numeric differences in text, such population comparisons are best summarized in a table or schematic figure contrasting Western, Asian, and other studied cohorts.

Patient factors may also influence vessel position. Higher body mass index has been associated with a slight lateral displacement of the IEA, although the magnitude of this effect appears modest and does not eliminate the paramedian danger zone.[10,17] Dynamic imaging during pneumoperitoneum has shown that abdominal insufflation causes some displacement of the anterior abdominal wall; however, the IEAs remain identifiable lateral to the rectus muscles, and insufflation does not negate the risk of vascular injury if trocars are placed within the usual danger zone.[19] This underscores the importance of selecting an initial avascular entry site and placing subsequent ports under direct visualization with awareness of epigastric vessel anatomy.[3]

Modern imaging studies consistently support the surgical principle that the inferior epigastric vessels occupy a paramedian band approximately 4-8 cm from the midline. Safe port placement is achieved by using the midline (linea alba) or positioning lateral trocars ≥8 cm from the midline and ≥5 cm above the pubic symphysis, with additional caution near the umbilical level.[9,10,11,16,18]

Surgical Anatomy Reviews and Safe Zone Guidelines

Clinical anatomy reviews and surgical guidelines synthesize cadaveric and imaging data into practical recommendations for trocar placement. Across multiple sources, the inferior epigastric arteries (IEAs) are consistently described as occupying a paramedian band approximately 4-8 cm lateral to the midline, defining a recognized “danger zone” for abdominal wall entry.[11,20] Accordingly, reviews recommend that trocars be placed either at the midline (linea alba) or ≥8 cm lateral to the midline to minimize the risk of epigastric vessel injury.[20,21]

The linea alba, extending from the xiphoid to the pubic symphysis, is reliably avascular except for small perforators and is widely endorsed as a safe entry site for laparoscopy.[5,22,23] Surgical texts and reviews commonly recommend midline or umbilical entry for the primary trocar, even in patients with prior lower abdominal incisions, as the deep epigastric vessels course lateral to this region.[3,24]

When midline entry is not feasible or for additional ports, guidelines emphasize sufficient lateral placement. A simplified and commonly cited principle is the “5 cm lateral to the rectus” rule, whereby ports placed ≥5 cm lateral to the lateral border of the rectus abdominis are considered safe and beyond the typical course of the IEAs.[10,16,25] The anterior superior iliac spine (ASIS) serves as a useful landmark, as ports placed near or just medial and superior to the ASIS are usually lateral to the epigastric vessels and avoid the paramedian danger zone.[16,25] In the upper abdomen, where the superior epigastric vessels lie closer to the midline, ports are safest when placed either close to the midline or well lateral, rather than in an intermediate paramedian position.[10,26]

Whenever possible, reviews recommend direct visualization of the IEAs, either laparoscopically (as lateral umbilical folds) or by transillumination of the abdominal wall; however, visualization may be limited in obese or dark-skinned patients, reinforcing the importance of landmark-based safe zone rules.[3,16,17,27] Some reviews briefly note anatomical variants, such as the corona mortis, which may be encountered near the pubic region and warrant caution with very low lateral ports, although this is primarily relevant to pelvic and groin surgery.[2,28]

In summary, surgical anatomy reviews consistently support a practical guideline: the IEAs occupy a 4-8 *cm* paramedian corridor, and safe trocar placement is achieved by using the midline (linea alba) or positioning ports ≥8 cm lateral to the midline, with the additional rule that ports ≥5 cm lateral to the

rectus border are generally safe.[10,11,20]

Gaps in the Literature and Future Directions

Variations highlighted in Table 1 have important clinical implications for surgical practice and emphasize the need for region-specific anatomic data. Despite the extensive literature on inferior epigastric artery (IEA) anatomy and laparoscopic safety, several focused gaps remain. Notably, there is a lack of dedicated Thai cadaveric or imaging studies examining the course of the IEA.[29] While most existing guidelines are derived from Western populations, limited evidence suggests that vessel position and side asymmetry may vary across populations. For example, an ultrasonographic study in a Uygur cohort demonstrated consistent left-right differences in IEA location.[9] Future Thai cadaveric or imaging studies are therefore needed to confirm whether the widely cited "4-8 cm from the midline" rule applies locally or requires modification.

Another gap lies in the lack of consensus on a single, practical safety standard. Although recommended distances such as ≥8 cm lateral to the midline[10] and variable cutoffs based on vertical level (e.g., ~6 cm at the ASIS and ~9 cm at the umbilicus) are broadly consistent, they are not identical.[18] This highlights the challenge of translating anatomic measurements into simple, universally applicable bedside rules. Accordingly, there is growing interest in patient-specific mapping strategies, such as preoperative or point-of-care Doppler ultrasound, to identify the IEA and mark individualized safe zones, particularly in patients with obesity or prior abdominal surgery where anatomy may be altered.[30]

Dynamic factors also remain incompletely studied. Limited data suggest that pneumoperitoneum and patient positioning may cause minor shifts in abdominal wall landmarks, but these changes do not eliminate the risk of IEA injury if trocars are placed within the paramedian danger zone[17,19] Most current recommendations therefore continue to rely on static anatomic assumptions derived from supine imaging or cadaveric studies.

Finally, there is a paucity of studies directly correlating defined anatomic "danger zones" with actual rates of IEA injury. Prospective studies or registries linking trocar position to port-site bleeding or vascular complications would strengthen the evidence base and help validate specific safety margins for different procedures.

Research priorities emerging from the literature include:

(a) Thai cadaveric and imaging studies to establish population-specific anatomy.

(b) development and validation of imaging-based protocols for patient-specific IEA mapping; and

(c) prospective clinical studies correlating port placement with vascular injury outcomes.

Conclusion

Our literature review identified consistent anatomical relationships and recommended safe zones for trocar insertion, as illustrated clearly in Table 1. In conclusion, The IEA runs 4-8 cm lateral to the midline, creating a danger zone for trocar placement. Safe zones are the midline (linea alba) and areas >8 cm lateral. Further Thai-specific studies are essential to refine guidelines and enhance laparoscopic safety.

Refference

1. Mustafa, A.Y.A.A., et al., Anatomical Study and Clinical Importance of the Inferior Epigastric Artery. *Int. J.* Morphol, 2021. 39(3): p. 688-691.
2. Kandinata N, Van Fossen K. Anatomy, abdomen and pelvis: Epigastric artery. In: *StatPearls*. StatPearls Publishing; 2025.
3. de Rosnay P, Chandiramani M, Usman S, Owen E. Injury of epigastric vessels at laparoscopy: diagnosis and management. *Gynecol Surg*. 2011;8(3):353-356. doi:10.1007/s10397-010-0653-5
4. Prevezanos D, Chaikalis L, Vlachos D, et al. Utilization of the inferior epigastric artery in renal transplantation for patients with severe vascular atherosclerosis: A strategy to optimize graft availability. *Cureus*. 2025;17(1):e77852. doi:10.7759/cureus.77852
5. Epstein J, Arora A, Ellis H. Surface anatomy of the inferior epigastric artery in relation to laparoscopic injury. *Clin Anat*. 2004;17(5):400-408. doi:10.1002/ca.10192

6. Kostov S, Dineva S, Kornovski Y, Slavchev S, Ivanova Y, Yordanov A. Vascular Anatomy and Variations of the Anterior Abdominal Wall - Significance in Abdominal Surgery. *Prague Med Rep.* 2023;124(2):108-142. doi:10.14712/23362936.2023.9
7. Joy P, Prithishkumar IJ, Isaac B. Clinical anatomy of the inferior epigastric artery with special relevance to invasive procedures of the anterior abdominal wall. *J Minim Access Surg.* 2017;13(1):18-21. doi:10.4103/0972-9941.181331
8. Pun TC, Chau MT, Lam C, Tang G, Leong L. Sonographic localization of abdominal vessels in Chinese women: its role in laparoscopic surgery. *Ultrasound Obstet Gynecol.* 1998;11(1): 59-61. doi:10.1046/j.1469-0705.1998.11010059.x
9. Gan Y, Xian Z, Liang M, et al. Anatomical characteristics of the inferior epigastric artery in Uygur and it's implication in the management of bleeding. *Asian J Surg.* 2023;46(10):4352-4356. doi:10.1016/j.asjsur.2022.11.094
10. Saber AA, Meslemani AM, Davis R, Pimentel R. Safety zones for anterior abdominal wall entry during laparoscopy: a CT scan mapping of epigastric vessels: A CT scan mapping of epigastric vessels. *Ann Surg.* 2004;239(2): 182-185. doi:10.1097/01.sla.0000109151.53296.07
11. Soren JK, Gond MS, Sharma D, Srivastav V. Variations in course of inferior epigastric artery- importance in laproscopic surgery. *J Med Dent Sci Res.* 2016;3(9):47-52.
12. Rao MP, Swamy V, Arole V, Mishra P. Study of the course of inferior epigastric artery with reference to laparoscopic portal. *J Minim Access Surg.* 2013;9(4):154-158. doi:10.4103/0972-9941.118826
13. Ramana B, Arora E, Belyansky I. Signs and landmarks in eTEP Rives-Stoppa repair of ventral hernias. *Hernia.* 2021;25(2):545-550. doi:10.1007/s10029-020-02216-4
14. Rao MP, Swamy V, Arole V, Mishra P. Study of the course of inferior epigastric artery with reference to laparoscopic portal. *J Minim Access Surg.* 2013;9(4):154-158. doi:10.4103/0972-9941.118826
15. Drakonaki EE, Adriaensen MEAPM, Al-Bulushi HIJ, Koliarakis I, Tsiaoussis J, Vanderdood K. Sonoanatomy of the ilioinguinal, iliohypogastric, genitofemoral, obturator, and pudendal nerves: a practical guide for US-guided injections. *J Ultrason.* 2022;22(88):e44-e50. doi:10.15557/JoU.2022.0008
16. *Basic principles and anatomy for the laparoscopic surgeon.* Abdominal Key. https://abdominalkey.com/basic-principles-and-anatomy-for-the-laparoscopic-surgeon/. Accessed March 15, 2025.
17. Andrade D, Abranches SD, Souza NS, Pereira-Correia JA, Prinz RAD.An analysis of the anatomical trajectory of the inferior epigastric arteries in the era of videolaparoscopic surgery: Is there in fact a "safety zone" for the prevention of iatrogenic lesions?*Eur J Anat.* 2012;16(1):43-48.
18. Joy P, Simon B, Prithishkumar IJ, Isaac B. Topography of inferior epigastric artery relevant to laparoscopy: a CT angiographic study. *Surg Radiol Anat.* 2016;38(3):279-283. doi:10.1007/s00276-015-1513-9
19. Burnett TL, Garza-Cavazos A, Groesch K, Robbs R, Diaz-Sylvester P, Siddique SA. Location of the deep epigastric vessels in the resting and insufflated abdomen. *J Minim Invasive Gynecol.* 2016;23(5):798-803. doi:10.1016/j.jmig.2016.04.002
20. Wong C, Merkur H. Inferior epigastric artery: Surface anatomy, prevention and management of injury. *Aust N Z J Obstet Gynaecol.* 2016;56(2):137-141. doi:10.1111/ajo.12426
21. Vilos GA, Ternamian A, Laberge PY, et al. Guideline no. 412: Laparoscopic entry for gynaecological surgery. *J Obstet Gynaecol Can.* 2021;43(3):376-389.e1. doi:10.1016/j.jogc.2020.12.012
22. GUARÍN-SASTRE, D.E. and A.F. YEPES, Surface Abdominal Anatomy, Aesthetics, and Proportionality, in TULUA Abdominoplasty. 2025, Elsevier. p. 13-22.
23. Egea AM. Surgical anatomy of the anterolateral wall of the abdomen and classification of the diastasis recti. In: New Concepts

in Diastasi Recti Surgery. *Springer Nature Switzerland* ; 2024:13-30.
24. Güven E, Dura MC, Aktürk H, Güraslan H. Safety of laparoscopic entry points in patients with a history of abdominal surgery: A research article. *Cureus.* 2023;15(10):e47244. doi:10.7759/cureus.47244.
25. Dennison A, Maddern G, Fan J, eds. *Bailey & Love's Essential Operations in Hepatobiliary and Pancreatic Surgery.* CRC Press; 2024.
26. Abdul-Ameer HH, Jaffar AA, Hassan HA. Surgical anatomy of the superior epigastric artery. *Iraqi J Med Sci.* 2006;5(1):3-7.
27. Madhok B, Nanayakkara K, Mahawar K. Safety considerations in laparoscopic surgery: A narrative review. *World J Gastrointest Endosc.* 2022;14(1):1-16. doi:10.4253/wjge.v14.i1.1
28. Cardoso GI, Chinelatto LA, Hojaij F, Akamatsu FE, Jacomo AL. Corona Mortis: A systematic review of literature. *Clinics (Sao Paulo).* 2021;76(e2182):e2182. doi:10.6061/clinics/2021/e2182
29. Tazi S. Comparison of breast sensibility following breast reconstruction with two different techniques: Deep inferior epigastric perforator flap and implant. *Eur Med J Oncol.* Published online 2024:116-128. doi:10.33590/emjoncol/ivcf4922
30. Munarriz R, Thirumavalavan N, Gross MS. Is there a role for vascular surgery in the contemporary management of erectile dysfunction? *Urol Clin North Am. 2021*;48(4): 543-555. doi:10.1016/j.ucl.2021.07.002

Ciatation

Garunyapakun P., Janta S., Liamvilairat G. and Kobutree P. Mapping Inferior Epigastric Artery Relative to Abdominal Landmarks: Defining Surgical Safe Zones and Risks. *J Chulabhorn Royal Acad.* 2026;8(2): 195-201. https://he02.tci-thaijo.org/index.php/jcra/article/view/276001

Online Access

https://he02.tci-thaijo.org/index.php/jcra/article/view/276001