Incidence of the Accessory Internal Thoracic Artery and Its Safety Area in the Thoracic Wall

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Objective: *To provide the incidence, origin, size and the safety area of the accessory internal thoracic artery (AITA) in the fourth intercostal space.*
Material and Method: *One hundred and thirty two thoracic cages were dissected and examined for the presence of AITA. The origin, course, diameter and location in the fourth intercostal space of detected AITA were investigated.*
Results: *AITA with diameter ranging from 0.6 to 3.05 (mean = 1.76 $\pm$ 0.69) millimeters existed in 10 of 132 (7.58%) cadavers. They originated from the upper part of the internal thoracic artery, close and inferior to the subclavian artery (0-3 cm, mean = 2.4 $\pm$ 0.78) and ran inferolaterally on the deep surface of the thoracic wall and ended in the second to the sixth intercostal spaces. Most of them ended in the fifth intercostal spaces (28.57%). The artery was present bilaterally in 4 cases (3.03%) and unilaterally in 6 cases (4.55%). Most of these arteries were located close to the midaxillary line (0-3 cm, mean = 1.73 $\pm$ 1.18) in the fourth intercostal space which is endangered in several surgical procedures such as thoracoscopy.*
Conclusion: *Even the incidence of AITA is low (7.57%) but when present, it is endangered in thoracic surgical procedures. The safety area of AITA for surgical procedures in the fourth intercostal space is at least 3 centimeters anterior to the midaxillary line.*

Keywords: *Accessory internal thoracic artery, Incidence, Safety area, Fourth intercostal space*

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The accessory internal thoracic artery (AITA), a branch of the internal thoracic artery is occasionally found during routine anatomical dissection. However, it is overlooked by common textbooks of anatomy and surgery. This artery was first described in 1730 by Heister[1,2] but its nomenclature was inconsistent. Some literatures described AITA as lateral costal artery[2-4], lateral internal mammary artery, and accessory internal mammary artery[5]. The present nomenclature, AITA, followed Nathan's terminology[2] which is more appropriate because it is a branch of the internal thoracic artery. The other names could cause some confusion. Even the occurrence of AITA was rare (15-30%) in the previous western studies[2,4,6,7], but the existence is important in certain clinical and surgical conditions. It was considered as the arterial myocardial revascularization and responsible for the "steal syndrome" of the coronary blood after coronary artery bypass grafting[8,9]. Due to its course and relations, this artery may be damaged by certain clinical procedures and cause serious haemothorax in the patient. The authors observation will contribute to knowledge of AITA incidence and characteristics, and provide the safety area for the surgical point of entry in thoracoscopic procedures.

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Material and Method

One hundred and thirty two embalmed cadavers from the Department of Anatomy, Faculty of Medicine, Khon Kaen University and Department of Anatomy, Phramongkutklao College of Medicine were studied. This research was done under the permission of the Faculty Research Committee (ID code: 52-03-3-00-002). The anterior thoracic walls were opened and examined thoroughly for the presence of AITA. The course and diameter of detected AITA were investigated. Diameter of AITA at the origin was

measured by using vernier caliper. The distance of AITA from the midaxillary line in the fourth intercostal space was then measured. The results were presented in term of number, percentages, range, mean and standard deviation (mean $\pm$ SD).

Results

The AITA was found in 10 of 132 cadavers or 7.58% (Table 1, Fig. 1). The artery was present bilaterally in 4 cases (3.03%) and unilaterally in 6 cases (4.55%). The total number of AITA found was 14 of 264 dissected internal thoracic arteries or 5.3%. It originated from the upper part of the internal thoracic artery, about 0-3.5 cm (mean = 2.4 $\pm$ 0.78) (Table 2) below the first part of the subclavian artery and ran an oblique course inferolaterally on the deep surface of the thoracic wall. The diameter of detected AITA ranged between 0.6-3.05 mm (mean = 1.76 $\pm$ 0.69) (Table 2). They ended in the second to sixth intercostal spaces (mostly ended in the fifth intercostal spaces as shown in Table 3) by anastomosing with the adjacent intercostal arteries. The artery with the larger diameter ended in the farther intercostal space. At the 4th intercostal space, 14.28% of AITA located exactly at the midaxillary line, the others located medially close to the midaxillary line (distance of 0-3 cm, mean = 1.73 $\pm$ 1.18). Two venae comitantes constantly accompanied the AITA as shown in Fig. 1.

Table 1. Incidence of the accessory internal thoracic artery (AITA)

	Number of cadavers
Total examined	132
Number of cadavers with AITA	10 (7.58%)
Bilateral	4 (3.03%)
Unilateral	6 (4.55%)
Right	4
Left	2

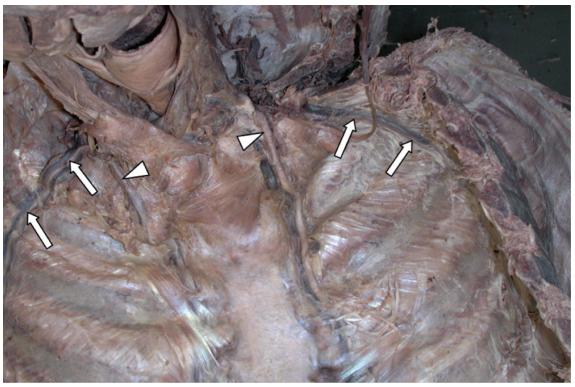

Fig. 1 The internal (deep) surface of the anterior thoracic wall showing bilateral accessory internal thoracic arteries (arrows) branching from the internal thoracic artery (arrowheads)

Discussion and Conclusion

The description of detected AITA regarding the origin and course are similar to the previous studies[2,5,7]. However, the present frequency of AITA (7.58%) was lower than the other findings (15-17%)[2,7]. The difference in frequency may be due to regional differences in the development in situ of the vascular system. Barberini[6] hypothesized that phylogenetically, AITA was the adaptation of the parietal arteries of the trunk to the growth and enlargement of the thoracic cage. This artery was also considered as the remnant of a pre-existing internal thoracic artery in the quadrupeds that became the AITA in mammals. It was considered as the cause of "steal syndrome" after myocardial revascularization using the internal thoracic artery[8,9]. Therefore, "steal syndrome" in coronary artery bypass grafting patient could be avoided by evaluating the presence of AITA. It is interesting that the location of AITA in the fourth intercostal space is close to the midaxillary line. Two of them located exactly at the midaxillary line in the fourth intercostal space which is the point of entry for thoracoscopic procedures[10,11]. Most AITA located medially close to the midaxillary line in the

Table 2. Characteristics of detected AITA

Number of AITA	Diameter at origin (mm)	Distance between subclavian artery and AITA origin (cm)	Distance from midaxillary line in the 4th intercostal space (cm)
14 (5.3%) (Rt = 8, Lt = 6)	0.6-3.05 (mean = 1.76 $\pm$ 0.69)	0-3.5 (mean = 2.4 $\pm$ 0.78)	0-3 (mean = 1.73 $\pm$ 1.18)

Table 3. Level of 14 AITA termination

Intercostal space termination	Numbers (%)
Second	3 (21.43)
Third	3 (21.43)
Fourth	3 (21.43)
Fifth	4 (28.57)
Sixth	1 (7.14)

fourth intercostal space. When present, they were endangered in several surgical procedures such as thoracoscopy and tapping the pleural cavity. Therefore, certain clinical procedures or surgical intervention of thorax should avoid this dangerous area. The safety distance of AITA in the fourth intercostal space is at least 3 centimeters anterior to the midaxillary line. Only a few AITA with a large diameter at origin could extend beyond the fifth intercostal space. Thus, surgical procedure in the sixth intercostal space is able to avoid AITA damage. Due to its course and relations, AITA may be affected in fracture ribs and may cause serious bleeding in the thorax.

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Potential conflicts of interest

None.

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อุบัติการณ์ของหลอดเลือดแดง accessory internal thoracic และบริเวณปลอดภัยในผนังอก

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วัตถุประสงค์: *เพื่อรายงานอุบัติการณ์, จุดกำเนิด, ขนาด และบริเวณปลอดภัยของ AITA ในช่องระหว่างซี่โครงช่องที่ 4*

วัสดุและวิธีการ: *ชำแหละผนังทรวงอกใน 132 ศพเพื่อค้นหา AITA พร้อมสำรวจจุดเริ่มต้น เส้นทาง เส้นผ่าศูนย์กลาง และตำแหน่งในช่องระหว่างซี่โครงช่องที่ 4*

ผลการศึกษา: *พบ AITA ขนาดเส้นผ่าศูนย์กลางตั้งแต่ 0.6-3.05 มม. (ค่าเฉลี่ย 1.76 $\pm$ 0.69 มม.) ในศพจำนวน 10 ร่าง (7.58%) จุดกำเนิดอยู่ที่ส่วนบนของหลอดเลือดแดง internal thoracic ใกล้ ๆ และอยู่ทางด้านล่างของหลอดเลือดแดง subclavian (0-3 ซม. ค่าเฉลี่ย 2.4 $\pm$ 0.78 ซม.) AITA มีเส้นทางลงล่างและออกข้างไปบนผนังทรวงอกด้านใน และสิ้นสุดในช่องระหว่างซี่โครงช่องที่ 5 (28.57%) พบ AITA ทั้งสองข้างในศพจำนวน 4 ร่าง (3.03%) และพบเพียงข้างเดียวในศพจำนวน 6 ร่าง (4.55%) หลอดเลือดส่วนใหญ่อยู่ใกล้เส้นกึ่งกลางรักแร้ (0-3 ซม. ค่าเฉลี่ย 1.73 $\pm$ 1.18 ซม.) ในช่องระหว่างซี่โครงช่องที่ 4 ซึ่งเสี่ยงต่อการบาดเจ็บในการผ่าตัดต่าง ๆ เช่นการส่องกล้องตรวจทรวงอก*

สรุป: *แม้อุบัติการณ์ของ AITA จะค่อนข้างต่ำ (7.57%) แต่การมีหลอดเลือดนี้ทำให้เสี่ยงต่อการได้รับบาดเจ็บระหว่างการผ่าตัดทรวงอกได้ บริเวณปลอดภัยของ AITA สำหรับการผ่าตัดที่ช่องระหว่างซี่โครงช่องที่ 4 คือ บริเวณห่างจากเส้นกึ่งกลางรักแร้มาทางด้านหน้าอย่างน้อย 3 ซม.*