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External diameter of possible alternative arteries used as conduit in coronary artery bypass graft for myocardial revascularization in Thai cadavers

Tanvaa Tansatit*

Vichai Benjacholamas** Natcharaporn Tokkunheng*

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Objectives : *To measure the external diameter and length of alternative arterial conduits for CABG ; the radial artery, ulnar artery, internal mammary arteries (IMA), right gastroepiploic artery (RGEA), peroneal artery and posterior tibial artery.*

- *To measure the external diameter of the mid left anterior descending artery (mid LAD).*
- *To assess the association between the external arterial diameter and height.*
- *To assess the association between the external diameters of arteries and body part representing by bony length.*
- *To assess the association between the length of arteries and height.*
- *To assess the association between the length of arteries and body part representing by bony length.*

Research design : *Descriptive study on 37 Thai adult cadavers whose age ranged from 45 to 85 years in the Department of Anatomy, Faculty of Medicine, Chulalongkorn University, Bangkok 10330, Thailand.*

Methods : *The external arterial diameters were measured 3 points in millimeters (mm) with a Vernier caliper precision 0.02 mm. Length of arteries and body part representing by bony length were measured in centimeters (cm) with a Tape line. Both external diameter and length of artery were summarized in mean $\pm$ SD.*

* Department of Anatomy, Faculty of Medicine, Chulalongkorn University

** Department of Surgery, Faculty of Medicine, Chulalongkorn University

Results : *Mean of external diameter of the radial artery, ulnar artery, IMA, RGEA, peroneal artery, posterior tibial artery and mid LAD were 2.67±0.4 mm, 2.22 ± 0.17 mm, 2.39 ± 0.24 mm, 2.65 ± 0.12 mm, 2.58 ±0.8 mm, 4.57±0.61mm, and 3.08 ± 0.62 mm, respectively.*

- *Mean length of the radial artery, ulnar artery, IMA,RGEA, peroneal artery and posterior tibial artery were 20.17 ± 1.68 cm, 21.98 ±1.68 cm,16.71 ± 1.02 cm, 16.28±1.71 cm, 23.01 ±1.43 cm and 23.27 ±1.67 cm, respectively.*
- *The external diameters of the studied arteries ; the radial artery, ulnar artery, IMA, peroneal artery and posterior tibial artery were not correlated with height ($p > 0.05$), except for the external diameter of RGEA ($p = 0.049$)and mid LAD ($p = 0.001$) were weakly and strongly positive correlation with height, respectively.*
- *The external diameters of the studied arteries ; the radial artery, ulnar artery, IMA, peroneal artery and posterior tibial artery were not correlated with body part representing by bony length ($p > 0.05$).*
- *Most the studied of arterial length; the radial artery, ulnar artery, IMA, peroneal artery and posterior tibial artery were strongly and positively correlated with both height and body part representing by bony length ($p < 0.001$). However, length of RGEA was not correlated with height ($p = 0.774$).*

Conclusions : *All the studied of the external arterial diameter (the radial artery,ulnar artery, IMA, RGEA, peroneal artery, posterior tibial artery, and mid LAD) were larger than standard size for CABG (more than 1.5 mm).*

- *The posterior tibial artery was the largest average of external diameter (4.57± 0.61mm) and the smallest of external diameter in ulnar artery (2.22 ± 0.17mm).*
- *Mean length of arteries ; the posterior tibial artery was the longest average length (23.27±1.67 cm) and the shortest length was 16.28 ±1.71 cm in RGEA.*
- *The external diameter of arteries cannot predicted from height and body part representing by bony length. However, length of arteries can be predicted from height and body part representing by bony length in Thai adult (age 45 - 85 years).*

Key words : *Coronary artery bypass graft, Arterial conduits.*

Reprint request : Tansatit T, Department of Anatomy, Faculty of Medicine, Chulalongkorn University, Bangkok 10330, Thailand.

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ธันวา ตันสถิตย์, วิชัย เบญจชลมาศ, นัชราภรณ์ ต๊กควรเฮง. ขนาดหลอดเลือดแดงที่อาจใช้เป็นทางเลือกสำหรับใช้ในการผ่าตัดหลอดเลือดหัวใจอุดตันในผู้ป่วยโรคกล้ามเนื้อหัวใจขาดเลือด : การศึกษาในศพคนไทย. จุฬาลงกรณ์เวชสาร 2544 ส.ค; 45(8): 671 - 83

วัตถุประสงค์ : *เพื่อทราบขนาดเส้นผ่าศูนย์กลางภายนอกและความยาวหลอดเลือดแดง radial, ulnar, internal mammary (IMA), right gastroepiploic (RGEA), peroneal และ posterior tibial ที่เป็นทางเลือกใหม่ในการทำ bypass graft*

- *เพื่อทราบขนาดเส้นผ่าศูนย์กลางนอกของ mid left anterior descending artery*
- *เพื่อประเมินความสัมพันธ์ระหว่างขนาดเส้นผ่าศูนย์กลางภายนอกของหลอดเลือดแดง และความสูง*
- *เพื่อประเมินความสัมพันธ์ระหว่างขนาดเส้นผ่าศูนย์กลางภายนอกของหลอดเลือดแดง และสัดส่วนร่างกายซึ่งอ้างอิงกับกระดูกใกล้หลอดเลือดแดง*
- *เพื่อประเมินความสัมพันธ์ระหว่างความยาวของหลอดเลือดแดงและความสูง*
- *เพื่อประเมินความสัมพันธ์ระหว่างความยาวหลอดเลือดแดงและสัดส่วนร่างกายซึ่งอ้างอิงกับกระดูกใกล้หลอดเลือดแดง*

รูปแบบการวิจัย : *การวิจัยเชิงพรรณนา ศึกษาในอาจารย์ใหญ่ที่บริจาคร่างกาย ณ ภาควิชากายวิภาคศาสตร์ คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย ปี 2541 - 42 ช่วงอายุ 45 - 85 ปีจำนวน 37 ราย*

วิธีการวัดผล : *ขนาดเส้นผ่าศูนย์กลางภายนอกของหลอดเลือดแดงวัดที่ 3 ตำแหน่งด้วย Vernier caliper precision 0.02 มม. บันทึกผลในหน่วยมิลลิเมตร (มม.) วัดความยาวหลอดเลือดแดงและสัดส่วนร่างกายซึ่งอ้างอิงกับกระดูกใกล้หลอดเลือดแดงด้วย Tape line บันทึกผลในหน่วยเซนติเมตร โดยทั้งขนาดเส้นผ่าศูนย์กลางภายนอกและความยาวหลอดเลือดแดงบันทึกผลเป็น mean $\pm$ SD*

ผลการศึกษา : *ค่าเฉลี่ยขนาดเส้นผ่าศูนย์กลางภายนอกของหลอดเลือดแดง radial, ulnar, IMA, RGEA, peroneal, posterior tibial และ mid LAD มีค่า 2.67 $\pm$ 0.4, 2.22 $\pm$ 0.17, 2.39 $\pm$ 0.24, 2.65 $\pm$ 0.12, 2.58 $\pm$ 0.8, 4.57 $\pm$ 0.61 และ 3.08 $\pm$ 0.62 มม ตามลำดับ*

- *ความยาวเฉลี่ยของหลอดเลือดแดง radial, ulnar, IMA, RGEA, peroneal และ posterior tibial มีค่า 20.17 ± 1.68, 21.98 ± 1.68, 16.71 ± 1.02, 16.28 ± 1.71, 23.01 ± 1.43 และ 23.27 ± 1.67 เซนติเมตร ตามลำดับ*
- *ขนาดเส้นผ่าศูนย์กลางภายนอกของหลอดเลือดแดง radial, ulnar, IMA, peroneal และ posterior tibial ไม่มีความสัมพันธ์กับความสูงและสัดส่วนร่างกายซึ่งอ้างอิงกับกระดูกใกล้หลอดเลือดแดง ($p > 0.05$) ยกเว้นใน RGEA ($p = 0.049$) และ mid LAD ($p = 0.001$) ที่ขนาดเส้นผ่าศูนย์กลางภายนอกของหลอดเลือดแดงมีความสัมพันธ์กับความสูง*
- *ความยาวของหลอดเลือดแดง radial, ulnar, IMA, peroneal และ posterior tibial มีความสัมพันธ์กับความสูงและสัดส่วนร่างกาย ซึ่งอ้างอิงกับกระดูกใกล้หลอดเลือดแดง ($p < 0.001$)*
  ยกเว้นใน RGEA ที่ความยาวหลอดเลือดแดงไม่มีความสัมพันธ์กับความสูง ($p = 0.774$)

สรุป : *หลอดเลือดแดงทั้งหมดที่ศึกษาพบว่าทุกเส้นมีขนาดเส้นผ่าศูนย์กลางภายนอกใหญ่กว่าขนาดมาตรฐาน (1.5 มม.) ซึ่งมีความเหมาะสมในการนำมาทำ CABG*
- *หลอดเลือดแดง posterior tibial มีขนาดผ่าศูนย์กลางใหญ่ที่สุด (4.57 ± 0.61 มม) และหลอดเลือดแดง ulnar มีขนาดเล็กที่สุด (2.22 ± 0.17 มม)*
- *หลอดเลือดแดง posterior tibial มีความยาวมากที่สุด (23.27 ± 1.67 ซม) และหลอดเลือดแดง RGEA มีความยาวสั้นที่สุด (16.28 ± 1.71 ซม)*
- *ไม่สามารถคาดเดาขนาดเส้นผ่าศูนย์กลางภายนอกของหลอดเลือดแดงจากความสูงและสัดส่วนร่างกายซึ่งอ้างอิงกับกระดูกใกล้หลอดเลือด แต่สามารถคาดเดาความยาวหลอดเลือดแดงจากความสูงและสัดส่วนร่างกาย ซึ่งอ้างอิงกับกระดูกใกล้หลอดเลือดได้ในคนไทยช่วงอายุวัยกลางคนถึงสูงวัย*

คำสำคัญ : *การผ่าตัดหลอดเลือดหัวใจ, ท่อทางเดินเลือดแดง*

Ishemic heart disease, the principal cause of death in Thai people in middle to late adulthood. Atheroclerosis is believed the main cause of coronary stenosis. Many factors of atherosclerosis disease was considered to be a degenerative process because of the accumulation of lipid and calcification by an increase in the thickening of the intimal area, a loss of elasticity, an increase in calcium content and lead to coronary atherosclerosis finally.[1,2]

Coronary artery bypass graft (CABG) is now an established and accepted method of treatment for patients who have obstructive coronary stenosis. In generally, the vessel size was greater than 1.5 mm in diameter are suitable for CABG.[3,4] Formerly, the saphenous vein and internal mammary arteries have been used as a conduit for routine. Subsequently, the right gastroepiploic artery, radial artery and inferior epigastric artery have been used an alternative conduits.[5] Guerra et al. (1993)[6] reported of left coronary arteries diameter at nearest LAD was 4.23 $\pm$ 0.85 mm. Shima et al. (1996)[7] reported of the radial and ulnar arteries diameter were 2.3 $\pm$ 0.5 mm,1.6 $\pm$ 0.5 mm, respectively. On the left side were significant differences between inner diameter of the proximal and distal sites. Feng (1997)[8] reported external diameter of IMA were 2.36 $\pm$ 0.55 mm. and the right IMA was significantly larger than left IMA. Strauch et al. (1993)[9] reported diameter of right gastroepiploic artery (RGEA) was 2.8 $\pm$ 0.90 mm. Yoshimura et al. (1990)[10] reported diameter of the peroneal artery was 1.6 $\pm$ 0.2mm. Wu et al. (1993)[11] reported external diameter of the posterior tibial artery was 10 $\pm$ 0.50 mm.

In the present study, we focus on external diameter and length of the radial artery, ulnar artery, internal mammary arteries, right gastroepiploic artery, peroneal artery, posterior tibial artery and external diameter of mid LAD for basic information to considered arterial conduits for CABG.

Method of measurement

How to measure the external arterial diameter: the cone shape tip calibrating probe was inserted lightly into lumen of arteries until it fixed then the external arterial diameter was measured at that end by a vernier and length of arteries were measured by a tape line (Table 1). For each measurement, each sample was measured 3 times to calculate the average. Statistical analysis with the SPSS version 9.0. The correlations were tested by the Simple linear regression and differences between the external diameters of arteries at each measurement site were tested by the Anova with repeated measures ($p < 0.05$). Furthermore, differences between the right side and left side of arterial length were tested by Matched-pairs t-test ($p < 0.05$).

Results

External diameter (Table 2)

Radial artery. The average external diameter of radial artery was 2.67 $\pm$ 0.4mm,n = 68. Each measurement site, it was significant difference of external diameter among the proximal, middle and distal sites ($p < 0.001$, n = 68).

Ulnar artery. The average external diameter of ulnar artery was 2.22 $\pm$ 0.17mm,n = 68. Each measurement site, it was significant difference of external diameter among the proximal, middle and distal sites ($p < 0.001$, n = 68).

IMA. The average external diameter of IMA was 2.39$\pm$ 0.24 mm, n = 62. Each measurement site, it was

Table 1. Measurement sites of external diameter, length of arteries and body part representing by bony length.

Artery	Measurement sites	
	Diameter (mm)	**Length(cm)**
RA	Proximal : bifurcation from brachial artery Distal : styloid process of radius Middle : between proximal and distal	Begin : near origin of radial recurrent artery End : styloid process of radius
Radius	-	Begin : head of radius End : styloid process of radius
UA	Proximal : bifurcation from brachial artery Distal : styloid process of ulna Middle : between proximal and distal	Begin : near origin of ulnar recurrent artery End : styloid process of ulna
Ulna	-	Begin : olecranon process of ulna End : styloid process of ulna
IMA	Proximal : bifurcation from subclavian artery Distal : xiphoid process of sternum Middle : between proximal and distal	Begin : bifurcation from subclavian artery End : xiphoid process of sternum
Sternum	-	Begin : sternal notch End : xiphoid process of sternum
RGEA	Proximal: near pyloric part of stomach Distal : near left gastroepiploic artery Middle : between proximal and distal	Begin : near pyloric part of stomach End : near left gastroepiploic artery
PA	Proximal : bifurcation from posterior tibial artery Distal : tip of lateral malleolus Middle : between proximal and distal	Begin : bifurcation from posterior tibial artery End : tip of lateral malleolus
Fibula	-	Begin : head of fibula End : tip of lateral malleolus
PT	Proximal : lower border of popliteus muscle Distal : tip of medial malleolus Middle : between proximal and distal	Begin : lower border of popliteus muscle End : tip of medial malleolus
Tibia	-	Begin : medial condyle of tibia End : tip of medial malleolus

RA: radial artery, UA: ulnar artery, IMA: internal mammary arteries, RGEA: right gastriepiploic artery, PA: peroneal artery, PT: posterior tibial artery, Proximal: start site of measurement, Distal: end site of measurement, Length : length of arteries were measured from begin site to end site.

significant difference of external diameter among the proximal, middle and distal sites ($p < 0.001$, n = 62).

RGEA. The average external diameter of RGEA (2.65± 0.12mm, n = 31) was significant differences between the proximal and middle sites ($p < 0.001$, n = 31). However, the measurement site of external diameter between the middle and distal sites was no significant difference of external diameter ($p = 0.172$, n = 31).

Peroneal artery. The average external diameter of peroneal artery was 2.58 ± 0.8 mm, n = 48. Each measurement site, it was significant difference of external diameter among the proximal, middle and distal sites ($p < 0.001$, n = 48).

Posterior tibial artery. The average external diameter was 4.57 ± 0.61mm, n = 62. Each measurement site, it was significant difference of external diameter among the proximal, middle and distal sites ($p < 0.001$, n = 60).

mid LAD. The average external diameter of mid LAD was 3.08 ± 0.62 mm, n = 32.

Vessels length (Table 2)

Radial artery. The average length was 20.17 ± 1.68cm,n = 68.On the right side(20.19 ± 1.69 cm) was significant differences from the left side (19.90 ± 1.67cm) ;$p = 0.001$, n = 60.

Ulnar artery. The average length was 21.98 ± 1.68 cm, n = 68. On the right side (21.97 ± 1.66 cm) was no significant differences from the left side (21.80 ± 1.75cm) ;$p = 0.235$,n = 58.

IMA. The average length was 16.71 ± 1.02 cm, n = 62. On the right side (16.70 ± 1.09 cm) was no significant differences from the left side (16.73 ± 0.97); $p = 0.505$, n = 62.

RGEA. The average length was 16.28 ± 1.71 cm, n = 31.

Peroneal artery. The average length was 23.01 ± 1.43 cm, n = 66. On the right side (22.68 ± 1.07 cm) was no significant differences from the left side (22.68 ± 1.12); $p = 0.958$,n = 52.

Posterior tibial artery. The average length was 23.27± 1.67cm, n = 64. On the right side (23.16 ± 1.58 cm) was no significant differences from the left side (23.01± 1.64) ; $p = 0.396$, n = 54.

Bone length

Radius. The average length was 22.09 ± 1.97cm,n = 68. On the right side (22.27 ± 2.01 cm) was significant differences from the left side (21.95 ± 1.94) ;$p < 0.001$,n = 64.

Ulna. The average length was 23.98 ± 2.25 cm, n = 68. On the right side (24.15 ± 2.19 cm) was significant differences from the left side (23.81 ± 2.24) ; $p < 0.001$, n = 64.

Sternum. The average length of sternum was 14.88 ± 1.13 cm, n = 31.

Fibula. The average length was 33.54 ± 1.71cm, n = 70. On the right side (33.46 ± 1.80 cm) was no significant differences from the left side (33.43 ± 1.83); $p = 0.826$, n = 64.

Tibia. The average length was 32.38 ± 1.72 cm,n = 68. On the right side (32.38 ±1.78 cm) was no significant differences from the left side (32.25 ± 1.79); $p = 0.485$, n = 66.

Regressions

All of the simple linear regression were recorded in the coefficient of determination (R- square; %), standard error of the estimate (SE), constant (a), regression coefficient (b) and *p*-value. In the simple linear regression of external arterial diameter and

Table 2. Length (cm), external diameter (mm),differences external diameter of arteries at proximal and distal sites (mm) and differences length of arteries at right side and left side(cm).

	Artery	Length	External diameter	Difference diameter I &II &III	Difference length left & right side
	mean ± SD(CV)	20.17 ± 1.68(8.33)	2.67 ± 0.4(14.98)		
RA	median ± IQR	20.11 ± 3.16	2.51 ± 0.74	significant	significant
	range	4.76	1.22	(p < 0.001, n: 68)	(p = 0.001, n: 60)
	mean ± SD(CV)	21.98 ± 1.68(7.64)	2.22 ± 0.17(7.66)		
UA	median ± IQR	21.91 ± 2.67	2.17 ± 0.17	significant	not significant
	range	6.47	0.78	(p < 0.001, n: 68)	(p = 0.235, n: 58)
	mean ±SD(CV)	16.71 ± 1.02(6.10)	2.39 ± 0.24(10.04)		
IMA	median ± IQR	16.52 ± 1.11	2.37 ± 0.26	significant	not significant
	range	4.22	1.04	(p < 0.001, n: 62)	(p =0.505, n:62)
	mean ± SD(CV)	16.28 ± 1.71(10.50)	2.65 ± 0.12(4.53)		
RGEA	median ± IQR	16.52 ± 2.60	2.66 ± 0.14	significant	-
	range	7.67	0.50	(p < 0.001, n: 31)	
	mean ±SD(CV)	23.01 ± 1.43(6.21)	2.58 ± 0.80(31.00)		
PA	median ± IQR	23.22 ± 1.44	2.38 ± 0.67	significant	not significant
	range	6.73	3.26	(p < 0.001, n: 48)	(p = 0.958, n: 52)
	mean ± SD(CV)	23.27 ± 1.67(7.18)	4.57 ± 0.61(13.35)		
PT	median ± IQR	23.83 ± 1.88	4.50 ± 1.02	significant *	not significant
	range	6.94	2.27	(p < 0.001, n: 60)	(p = 0.396, n: 54)
mid	mean ± SD(CV)		3.08 ± 0.62(20.13)		
LAD	median ± IQR	-	2.85 ± 0.55	-	-
	range		2.50		

RA: radial artery, UA: ulnar artery, IMA: internal mammary arteries, RGEA: right gastroepiploic artery, PA: peroneal artery, PT: posterior tibial artery, mid LAD: mid left anterior descending artery, IQR: interquartile range, CV: coefficient of variation, I : proximal site, II : middle site, III: distal site, n: number of subjects, PT* : The external diameter of posterior tibial artery was highly differ between the proximal site (6.53 ± 0.80 mm), middle site (4.30 ± 0.85 mm) and distal site (2.64 ± 0.58 mm).

height (Table 3) we found that ; mid LAD was maximum R-square value (29.6 %), RGEA was R-square value 12.7 %, IMA was R-square value 10.4 %, radial artery was R-square value 6.6 %, posterior tibial artery was R-square value 1.2 %, peroneal artery was R-square value 0.3 %, ulnar artery was minimum R-square (0.1 %), respectively. Moreover, the simple linear regression of external arterial diameter and body part representing by bony length (Table 3) was maximum R-square value in radial artery (8.6 %), IMA was R-square value 6.1 %, ulnar artery was R-square value 0.5 %, peroneal artery was R-square value 0.1 %. In addition, the simple linear regression of arterial length and height (Table 4) was maximum R-square in peroneal artery (75.4 %), radial artery was R-square value 73.6 %, IMA was R-square value 66.9 %,

Table 3. Simple linear regression of external diameter (mm) and height (cm), body part representing by bony length (cm).

External	Height						Bone length					
diameter	R^2	SE	a	b	P -value	N	R^2	SE	a	b	P -value	N
RA	6.6	0.395	0.411	1.37E-02	0.144	68	8.6	0.390	1.345	6.00E-02	0.092	68
UA	0.10	0.168	2.124	5.57E-04	0.887	68	0.50	0.168	2.342	-5.23E-03	0.690	68
IMA	10.4	0.232	0.781	9.76E-03	0.077	62	6.1	0.238	1.606	5.273E-02	0.179	31
RGEA	12.7	0.113	1.727	5.59E-03	0.049	31	-	-	-	-	-	-
PA	0.30	0.818	3.534	-5.75E-03	0.801	48	0.10	0.819	3.004	-1.26E-02	0.907	48
PT	1.20	0.612	3.121	8.82E-03	0.561	62	0.00	0.616	4.684	-3.41E-03	0.959	62
mid LAD	29.6	0.528	-3.96	4.27E-02	0.001	32	-	-	-	-	-	-

R^2 : coefficient of determination (%),SE : standard error of the estimate, a : constant, b: regression coefficient, N : number of subjects, RA : radial artery, UA : ulnar artery, IMA: internal mammary arteries, RGEA: right gastroepiploic artery, PA: peroneal artery, PT: posterior tibial artery, mid LAD : mid left anterior descending artery.

posterior tibial artery was R-square value 50.1 %, ulnar artery was R-square value 40.9 %, RGEA was minimum R-square value 0.3 %, respectively. Furthermore, the simple linear regression of arterial length and body part representing by bony length (Table 5) was maximum R-square in radius (86.6 %),sternum was R-square value 76.5 %, fibula was R-square value 72.4%, ulna was R-square value 65.4 %, tibia was minimum R-square 58.2 %, respectively.

Table 4. Simple linear regression of arterial length(cm) and height (cm).

Length of arteries	**Height**					
	R^2	**SE**	**a**	**b**	**p**	**N**
RA	73.6	0.878	-11.5	0.191	0.00	68
UA	40.9	1.31	-1.6	0.142	0.00	68
IMA	66.9	0.60	-0.62	0.105	0.00	62
RGEA	0.3	1.738	18.26	-1E-02	0.774	32
PA	75.4	0.721	-4.61	0.168	0.00	66
PT	50.1	1.20	-2.76	0.158	0.00	64

R^2: coefficient of determination (%), SE : standard error of the estemate, a : constant, b : regression coefficient, *P : p*-value, N: number of subjects, RA : radial artery, UA : ulnar artery

Table 5. Simple linear regression of arterial length (cm) and body part representing by bony length (cm).

Length of	**Bone length**					
arteries	**R^2**	**SE**	**a**	**b**	**p**	**N**
RA	86.6	0.626	2.578	0.796	0.00	68
UA	65.4	1.00	7.492	0.604	0.00	68
IMA	76.5	0.504	4.960	0.790	0.00	31
RGEA	-	-	-	-	-	-
PA	72.4	0.764	-0.98	0.718	0.00	66
PT	58.2	1.10	-0.54	0.737	0.00	64

IMA: internal mammary arteries, RGEA : right gastroepiploic artery, PA: peroneal artery, PT : posterior tibial artery.

Discussions

From our results, all the studied of external arterial diameter (the radial artery, ulnar artery, IMA, RGEA, peroneal artery, posterior tibial artery and mid LAD) were larger than standard size for CABG (1.5 mm), the largest average of external diameter was 4.57 ± 0.61mm in the posterior tibial artery and the smallest of external diameter in the ulnar artery was 2.22 ± 0.17mm. Mean length of arteries, the longest average length was 23.27 ± 1.67cm in the posterior tibial artery and the shortest length was 16.28 ± 1.71cm in RGEA (Table 2).

The posterior tibial artery was the largest average external diameter (4.57 ± 0.61mm), and the longest average length (23.27 ± 1.67cm),and its giving off many branches distributed to leg, and variable in its size and less prone to vasospasm. The radial artery and IMA were satisfactory of external diameter (2.67±0.4 mm, 2.65 ±0.12 mm, respectively), there were good length, but its greater tendency to vasospasm.[12-14] The radial and ulnar arteries were necessitates prior assessment of collateral circulation to the hand by the Allen test,[15,16] with visual assessment the skin of the palm and digits. The peroneal artery was good length, but variable in its size and more complicate to harvest with tibial nerve. The right gastroepiploic artery, its good length and caliber, but its greater tendency to vasospasm.[17,18] Currently, the radial and gastroepiploic arteries are widely used for CABG. But some patients are lack graft conduits for redo CABG, thus another source of conduit must be considered. The posterior tibial artery has been widely used for vascular flaps in plastic and reconstruction surgery.[19] In patient, who did not have diabetes mellitus and also did not have peripheral vascular disease. Therefore, it was considered to use the posterior tibial artery for CABG. The external diameter of this artery is larger than other arteries, such as the radial artery, ulnar artery and IMA. The distal diameter of posterior tibial artery was around 2.6 mm, the middle diameter was around 4.3 mm and the proximal diameter was about 6.5 mm. A proximal anastomosis at the ascending aorta is easier when compare to another artery. [20]

The regression, In all the simple linear regressions of external arterial diameter and height, body part representing by bony length were small R-square values (less than 50 %). Most of the external arterial diameters; radial artery, ulnar artery, IMA, peroneal artery and posterior tibial artery were not correlated with height ($p > 0.05$). However, the external diameters of RGEA ($p = 0.049$) and mid LAD ($p = 0.001$) were weakly and strongly and positive correlation with height, respectively. In the simple linear regression of external arterial diameter and body part representing by bony length, the external diameters of radial artery, ulnar artery, IMA, peroneal artery and posterior tibial artery were not correlated with body part representing by bony length ; $p > 0.05$ (Table 3). Moreover, the simple linear regression of arterial length and height was maximum R-square value in peroneal artery (75.4 %),radial artery (73.6 %) and minimum R-square in RGEA (0.3 %). In most of the linear regressions between length of arteries and height, length of arteries were strongly and positively correlated with height ($p < 0.001$). However, length of RGEA was not correlation with height ; $p = 0.774$ (Table 4 and Figs.1 and 2). In addition, all the simple linear regressions of arterial length and body part representing by bony length were good R-square

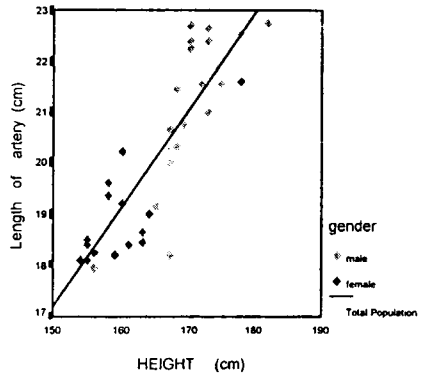

Figure 1. Scattergram of radial artery length (cm) versus height (cm):correlation coefficient 0.858, n: 68.

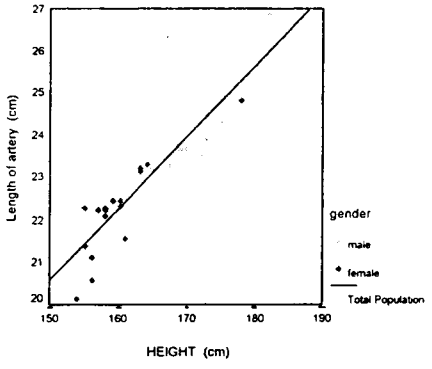

Figure 2. Scattergram of peroneal artery length (cm) versus height (cm):correlation coefficient 0.868, n:66.

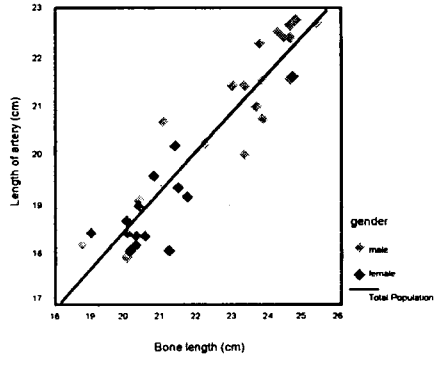

Figure 3. Scattergram of radial artery length (cm) versus bone length ; radius(cm): correlation coefficient 0.931,n:68.

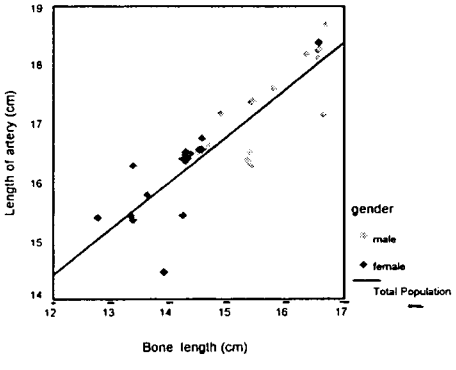

Figure 4. Scattergram of IMA length (cm) versus bone length; sternum (cm): correlation coefficient 0.875, n:31.

values (more than 50 %) and arterial length were strongly and positive correlation with body part representing by bony length; $p < 0.001$ (Table 5 and Figs.3 and 4).

In our study, we found basis an anatomical documented of arterial for regarding to selected alternative arterial conduits in CABG. These finding suggest that a new choice for CABG; the posterior tibial artery its more suitable in size, length and tendency to vasospasm.

In conclusion, from our finding, the largest average of external diameter was 4.57 ± 0.61mm in the posterior tibial artery and the smallest of external diameter in the ulnar artery was 2.22 ± 0.17mm. The longest average length was 23.27 ± 1.67cm in the posterior tibial artery and the shortest length was 16.28 ± 1.71cm in RGEA. The external diameter of arteries cannot predicted from height and body part representing by bony length, but able to predicted length of arteries from height and body part representing by bony length in Thai adult from middle to late age.

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