Research Articles

New branching patterns of the subclavian arteries found in Thai native dogs

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Abstract

The majority of dogs in Thailand are Thai native dogs, but their anatomy is rarely recorded. In this study, we aimed to investigate the anatomical variation of subclavian arteries of dogs in Thailand. We observed 43 cadavers of Thai native dogs compared to 15 cadavers of other breeds during teaching veterinary anatomy. Four new branching patterns of subclavian arteries were found and named as type Va, Vb/Vd, VIb, and VIIb/VIId. Type V had had vertebral artery as the first branch, then costocervical and superficial cervical arteries arose together. Type Vb/Vd, the internal thoracic artery arose opposite either to the costocervical trunk or the superficial cervical artery while type Va the internal thoracic artery arose after the superficial cervical artery, but not opposite to the costocervical trunk. VIIb/VIId was described as vertebral artery is the first branch and then common trunk of costocervical and superficial cervical arteries, the internal thoracic artery arose opposite either to the costocervical trunk or the superficial cervical artery. These new patterns accounted for 5.9% of Thai native dogs in this study. From the new patterns, we created the new model that cover all possible branching patterns of the subclavian artery (26 variations). Notably, the highest frequency of branching patterns in Thai native dogs was type I (60.5%), specifically type Ib (33.7%), which was also the major pattern for both sides of subclavian arteries and both sexes of dogs. Type Ib was described as the vertebral artery was the first branch, then the costocervical trunk, later the superficial cervical and the internal thoracic arteries arose oppositely. This knowledge is useful for veterinary anatomical education, physiology, imaging diagnosis, and the surgical treatment for canine thorax, particularly in Thai dogs.

Keywords: Anatomical variation, Subclavian artery, Thai native dogs

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รูปแบบใหม่ของการแตกสาขาของเส้นเลือด Subclavian arteries พบในสุนัขไทยพื้นเมือง

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บทคัดย่อ

ประชากรสุนัขส่วนใหญ่ในประเทศไทยคือสุนัขไทยพื้นเมือง แต่ข้อมูลของสุนัขพื้นเมืองไทยนั้นกลับไม่ค่อยมีคนรายงาน ในการทดลองนี้ มีวัตถุประสงค์ในการศึกษาความหลากหลายทางลักษณะทางกายวิภาคของเส้นเลือด subclavian artery ในสุนัขไทยพื้นเมือง เราทำการศึกษาจากซากสุนัขในระหว่างการเรียนการสอนกายวิภาคศาสตร์ของสุนัข โดยทำการศึกษาสุนัขพื้นเมืองไทย 43 ตัว และพันธุ์อื่นอีก 15 ตัว จากการศึกษาพบ รูปแบบใหม่ของการแตกสาขาของเส้นเลือด subclavian arteries สี่แบบ ในสุนัขพื้นเมืองไทย และตั้งชื่อว่า type Va, Vb/Vd, VIb, และ VIIb/VIId สำหรับ Type V มี vertebral artery เป็นแขนงแรก ตามด้วย costocervical และ superficial cervical arteries ที่ออกมาพร้อมกัน โดย type Vb/Vd มี internal thoracic artery ออกมาตรงข้ามกับ costocervical trunk หรือ superficial cervical artery ในขณะที่ Va นั้นมี internal thoracic artery ออกมาหลังจาก superficial cervical artery แต่ไม่ตรงกันข้ามกับ costocervical trunk. ใน type VIIb/VIId นั้น vertebral artery เป็นแขนงแรก ตามด้วย common trunk ของ costocervical และsuperficial cervical arteries ส่วน internal thoracic artery ออกมาตรงกันข้ามกับ costocervical trunk หรือ superficial cervical artery. รูปแบบใหม่นี้พบประมาณ 5.9% ของสุนัขไทยพื้นเมือง หลังจากนั้นเราทำการออกแบบรูปแบบความเป็นไปได้ทั้งหมดของ การแตกสาขาของเส้นเลือด subclavian arteries โดยมีทั้งหมด 26 แบบ จากการศึกษาพบว่า รูปแบบ type I พบมากที่สุด (60.5%) ในสุนัขไทยพื้นเมือง โดยเฉพาะ type Ib (33.7%) ซึ่งสามารถพบได้ทั้งเพศผู้และเพศเมีย Type Ib มีลักษณะคือ แขนงแรกคือ vertebral artery ต่อมาคือ costocervical trunk และคู่สุดท้ายที่ออกมาพร้อมกันคือ superficial cervical artery และ internal thoracic artery ซึ่งจะอยู่ตรงข้ามกัน ความรู้ที่ได้จากการทดลองนี้จะมีประโยชน์ในการเรียนกายวิภาคศาสตร์ สรีรวิทยา การวินิจโรคจากภาพถ่ายรังสี และการรักษาโดยการผ่าตัดในช่องอก โดยเฉพาะในสุนัขไทย

คำสำคัญ : ความหลากหลายทางกายวิภาคศาสตร์, Subclavian artery, สุนัขไทยพื้นเมือง

Introduction

Currently, there are more than three hundred dog breeds that have been recognised by the Fédération Cynologique Internationale (FCI), the world dog organisation (2017) according to their size, physical appearance, and behaviour. Each breed has a unique genetic signature (Parker, 2012) resulting in differences in physiology and anatomy (Fleischer et al., 2008; Schoenebeck and Ostrander, 2013; Oswald et al., 2015). However, approximately more than 70% the global dog population is not pure breed, it is the free-breeding dogs (also known as the mongrel) which their genetics and appearance are different from pure breed dogs (Hughes and Macdonald, 2013; Pilot et al., 2015). The genetics and characteristics of pure-breed dogs is defined by human breeding practices whereas the free-breeding dogs' genetics is largely defined by ecological and evolutionary processes such as dispersal pattern, mate choice, and natural selection (Pilot et al., 2015).

In Thailand, more than 7 million dogs have been officially recorded by the Bureau of Disease Control and Veterinary Service (2016); however, there are no reports regarding the distribution of dog breeds and free-breeding dog. From the records of the Mahidol University's Animal Hospital, it was observed that more than 90% of the dog population in Thailand are free-breeding dogs, and most of them were Thai native dogs (unpublished data). We describe the appearances of Thai native dogs as short hair, with fur colour of black, white, brown, or mixed, and a weight between 10-15 kg. The Thai native dogs are usually free-breeding dogs (more than 90%), except Thai Ridgeback which are registered to the FCI. The genetic study demonstrate that both Thai free-breeding-native and Ridgeback dogs are ancient and highly related, they are originated from the wolf (Pilot et al., 2015; Wang et al., 2016; Boonyaprakob et al., 2017).

The canine subclavian arteries are the major vessels circulating by distributing the blood from the heart to the forelimbs, neck, and thoracic area, and they have four branches: the vertebral artery, the costocervical trunk, the superficial cervical artery, and the internal thoracic artery (Dyce et al., 2010; Evans and de Lahunta, 2010, 2013). The branching order of the subclavian arteries in dogs is previously described in detail in two pure breeds, and these reports reveal the difference in the branching pattern of the subclavian artery between the German Shepherd (Kim et al., 2010) and the Greyhound (Pols et al., 2016).

Knowledge of an anatomical variation is important in order to understand physiology and pathology for each type of dogs. However, textbooks for teaching canine anatomy (Nickel et al., 1976; Pasquini et al., 2003; Adam, 2004; Dyce et al., 2010; Evans and de Lahunta, 2010) rarely show anatomical variations. There are limited research papers described anatomical variations of canine vessels, only few vessels has been reported including the celiac artery (Abidu-Figueiredo et al., 2005; Roza et al., 2012), internal iliac arteries (Avedillo et al., 2015, 2016a, 2016b), renal arteries (Sajjarengpong and Adirektaworn, 2006), and coronary arteries (Noestelthaller et al., 2007).

The knowledge of the variation of subclavian artery is helpful for imaging diagnosis and surgical treatment. Some abnormalities of the canine subclavian artery and its branches are reported; for example, the aberrant subclavian artery, stenosis of the subclavian artery, and occlusion of the vertebral artery (Buchanan, 2004; Dekleer, 1971; He et al., 2002; Westworth et al., 2006; Yoon and Jeong, 2011). These abnormalities are

serious illness which can eventually cause death if left untreated, and the accurate imaging diagnosis is required before the surgical treatment can be performed (Buchanan, 2004; Yoon and Jeong, 2011; Kim et al., 2017). Furthermore, the knowledge of canine subclavian artery and their branches is also useful for the human disease model studies such as hypertension, stenosis and atherosclerosis (Cohn et al., 2003; Saha et al., 2017).

Therefore, it is important to understand the anatomy of Thai native dogs whose anatomical structures have not been fully documented. Our research project aimed to investigate the variation of canine anatomy in Thai native dogs compared to other dogs. In this study, we investigated the anatomical variation of branching patterns of subclavian arteries.

Materials and methods

Cadavers

All canine cadavers from this study were free from infectious diseases. They were donated to the Faculty of Veterinary Science for teaching canine gross anatomy. This study was performed in dissected cadavers previously examined by veterinary students of the Faculties of Veterinary Science from Mahidol University and Chulalongkorn University. This research project was approved by Animal Care and Use Committee, Faculty of Veterinary Science, Mahidol University (MUVS-2017-11-52).

Forty-three cadavers of Thai native dogs were observed and compared with 15 non-Thai dogs consisting of four Golden Retrievers, three Beagles, three Labrador Retrievers, one Dalmatian, one French Bulldog, two Siberians Huskies, and one Poodle.

Cadaver preparation

All donated cadavers were kept either in either 4°C refrigerator (Chulalongkorn University) or -20°C freezer (Mahidol University) until embalming. A preservative chemical solution (a mixture of formaldehyde, glycerine, and phenol) was injected to the left common carotid artery of the specimens. After seven days, 200 to 500 mL of coloured latex were introduced into the left common carotid artery by a pressure pump. The cadavers were then kept at room temperature for a day before they were immersed into the diluted formalin solution for long-term storage.

Branching pattern

Initially, we used the previous classification (Kim et al., 2010; Pol et al., 2016) to observe the cadavers in this study. The initial study by Kim et al. (2010) describe 12 variations while Pol et al. (2016) suggest two more variations. After the observation from our canine cadavers, we found that the previous classification did not cover all the possibility of branching pattern. Therefore, we created the new branching model (26 branching patterns) to cover all possibilities (Fig 1). The new variations were divided into7 main types (type I-VII) based on the appearance of the first and second branches of the subclavian artery (Table 1). For each main type, 4 subtypes (a-d) were categorised based on the level of the internal thoracic artery related to the superficial cervical artery and the costocervical trunk (Table 2). Based on this category, type Vb and Vd were the same pattern as well as type VIIb and VIId, we then called type Vb/Vd and VIIb/VIId.

Statistical analysis

The statistical difference of the occurrence of branching pattern was calculated using GraphPad statistical software (https://www.graphpad.com/) using Fisherís exact test. P-value less than 0.05 was considered as a statistical significance in this study.

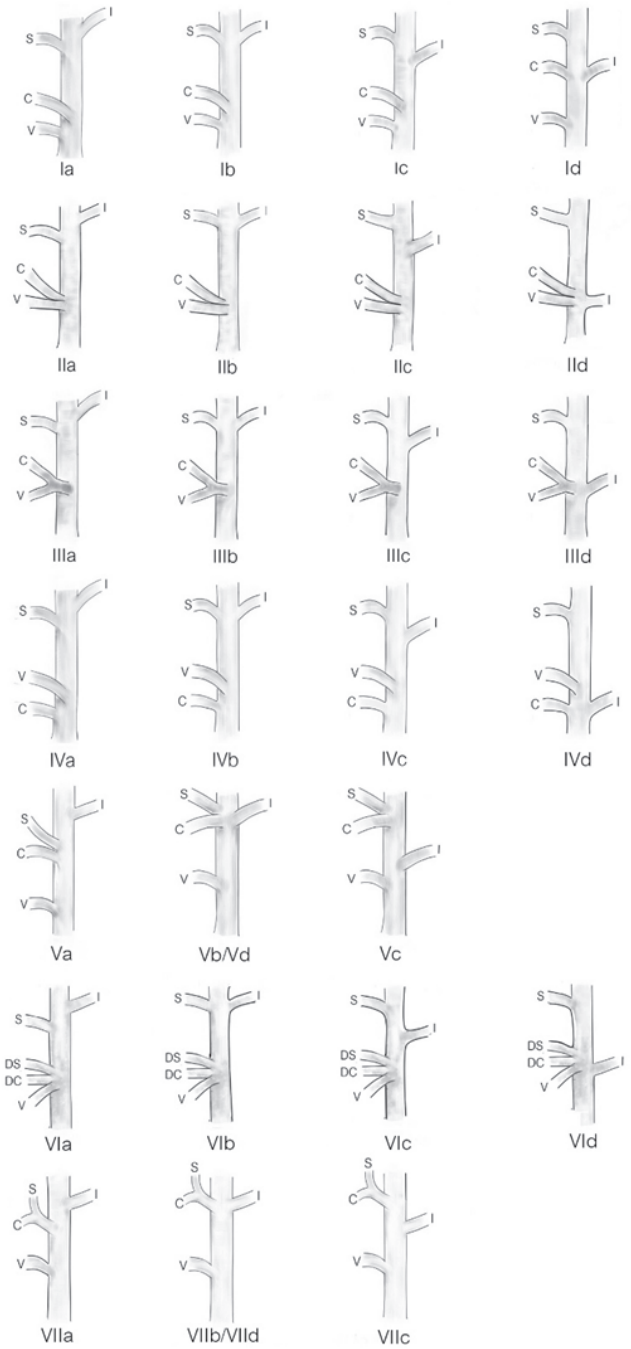

Fig. 1 The illustrated model of branching patterns of canine subclavian arteries. V = Vertebral artery. C = Costocervical trunk. S = Superficial cervical artery. I = Internal thoracic artery. DS = Dorsal scapular artery. DC = Deep cervical artery.

Table 1. Main types of subclavian variations based on the appearance of first and second branches of subclavian artery.

Type 1st	branch 2nd	branch
I	Vertebral artery	Costocervical trunk
II	Vertebral & Costocervical arteries	Superficial cervical artery
III	Common trunk of Vertebral & Costocervical arteries	Superficial cervical artery
IV	Costocervical trunk	Vertebral artery
V	Vertebral artery	Costocervical & Superficial cervical arteries
VI	Vertebral, Dorsal scapular & Deep cervical arteries*	Superficial cervical artery
VII	Vertebral artery	Common trunk of Costocervical & Superficial cervical arteries

*There was no costocervical trunk in this pattern

Table 2. Subtype of subclavian variations base on the level of the internal thoracic artery related to the superficial cervical artery and the costocervical trunk.

Subtype	Description
a	The internal thoracic artery arose after the superficial cervical artery, and not opposite to costocervical trunk
b	The internal thoracic arteries arose at the same level of the superficial cervical artery
c	The internal thoracic artery arose before the superficial cervical artery, and not opposite to the costocervical trunk
d	The internal thoracic artery arose opposite to the costocervical trunk

Table 3. Branching patterns of left and right subclavian arteries in all dogs.

Type	Subtype	Case n (%)	Left n (%)	Right n (%)
I	a	6 (5.2)	4 (6.9)	2 (3.4)
	b	38 (32.8)	13 (22.4)	25 (43.1)
	c	15 (12.9)	10 (17.2)	5 (8.6)
	d	9 (7.8)	4 (6.9)	5 (8.6)
	Subtotal	**68 (58.6)**	**31 (53.4)**	**37 (63.8)**
II	a	5 (4.3)	1 (1.7)	4 (6.9)
	b	16 (13.8)	9 (15.5)	7 (12.1)
	c	7 (6.0)	5 (8.6)	2 (3.4)
	d	-	-	-
	Subtotal	**28 (24.1)**	**15 (25.9)**	**13 (22.4)**
III	a	2 (1.7)	-	2 (3.4)
	b	5 (4.3)	2 (3.4)	3 (5.2)
	c	1 (0.9)	-	1 (1.7)
	d	-	-	-
	Subtotal	**8 (6.9)**	**2 (3.4)**	**6 (10.3)**
IV	a	-	-	-
	b	7 (6.0)	7 (12.1)	-
	c	-	-	-
	d	-	-	-
	Subtotal	**7 (6.0)**	**7 (12.1)**	**0 (0.0)**
V	a	1 (0.9)	-	1 (1.7)
	b/d	2 (1.7)	1 (1.7)	1 (1.7)
	c	-	-	-
	Subtotal	**3 (2.6)**	**1 (1.7)**	**2 (3.4)**
VI	a	-	-	-
	b	1 (0.9)	1 (1.7)	0 (0.0)
	c	-	-	-
	d	-	-	-
	Subtotal	**1 (0.9)**	**1 (1.7)**	**0 (0.0)**
VII	a	-	-	-
	b/d	1 (0.9)	1 (1.7)	-
	c	-	-	-
	Subtotal	**1 (0.9)**	**1 (1.7)**	**0 (0.0)**
	Total	**116**	**58**	**58**

Table 4. Branching patterns of subclavian arteries of Thai native dogs compared to non-Thai native dogs.

Type	Subtype	Thai native dogs			Non-Thai native dogs		
		Case n (%)	Left n (%)	Right n (%)	Case n (%)	Left n (%)	Right n (%)
I	a	5 (5.8)	3 (7.0)	2 (4.7)	1 (3.3)	1 (6.7)	-
	b	29 (33.7)	11 (25.6)	18 (41.9)	9 (30.0)	2 (13.3)	7 (46.7)
	c	11 (12.8)	7 (16.3)	4 (9.3)	4 (13.3)	3 (20.0)	1 (6.7)
	d	7 (8.1)	3 (7.0)	4 (9.3)	2 (6.7)	1 (6.7)	1 (6.7)
	Subtotal	**52 (60.5)**	**24 (55.8)**	**28 (65.1)**	**16 (53.3)**	**7 (46.7)**	**9 (60.0)**
II	a	2 (2.3)	-	2 (4.7)	3 (10.0)	1 (6.7)	2 (13.3)
	b	11 (12.8)	6 (14.0)	5 (11.6)	5 (16.7)	3 (20.0)	2 (13.3)
	c	4 (4.7)	3 (7.0)	1 (2.3)	3 (10.0)	2 (13.3)	1 (6.7)
	d	-	-	-	-	-	-
	Subtotal	**17 (19.8)**	**9 (20.9)**	**8 (18.6)**	**11 (36.7)**	**6 (40.0)**	**5 (33.3)**
III	a	1 (1.2)	-	1 (2.3)	1 (3.3)	-	6.7
	b	5 (5.8)	2 (4.7)	3 (7)	-	-	1 (6.7)
	c	1 (1.2)	-	1 (2.3)	-	-	-
	d	-	-	-	-	-	-
	Subtotal	**7 (8.1)**	**2 (4.7)**	**5 (11.6)**	**1 (3.3)**	**0 (0.0)**	**1 (6.7)**
IV	a	-	-	-	-	-	-
	b	5 (5.8)	5 (11.6)	-	2 (6.7)	2 (13.3)	-
	c	-	-	-	-	-	-
	d	-	-	-	-	-	-
	Subtotal	**5 (5.8)**	**5 (11.6)**	**0 (0.0)**	**2 (6.7)**	**2 (13.3)**	**0 (0.0)**
V	a	1 (1.2)	-	1 (2.3)	-	-	-
	b/d	2 (2.3)	1 (2.3)	1 (2.3)	-	-	-
	c	-	-	-	-	-	-
	Subtotal	**3 (3.5)**	**1 (2.3)**	**2 (4.7)**	**0 (0.0)**	**0 (0.0)**	**0 (0.0)**
VI	a	-	-	-	-	-	-
	b	1 (1.2)	1	-	-	-	-
	c	-	-	-	-	-	-
	d	-	-	-	-	-	-
	Subtotal	**1 (1.2)**	**1 (2.3)**	**0 (0.0)**	**0 (0.0)**	**0 (0.0)**	**0 (0.0)**
VII	a	-	-	-	-	-	-
	b/d	1 (1.2)	1 (2.3)	-	-	-	-
	c	-	-	-	-	-	-
	Subtotal	**1 (1.2)**	**1 (2.3)**	**0 (0.0)**	**0 (0.0)**	**0 (0.0)**	**0 (0.0)**
	Total	**86 (100)**	**43 (100)**	**43 (100)**	**30 (100)**	**15 (100)**	**15 (100)**

Table 5. Branching patterns of subclavian arteries of Thai native dogs, comparison between male and female dogs.

Type	Subtype	Thai male dogs			Thai female dogs		
		Case n (%)	Left n (%)	Right n (%)	Case n (%)	Left n (%)	Right n (%)
I	a	4 (8.3)	2 (8.3)	2 (8.3)	1 (2.6)	1 (5.3)	-
	b	12 (25.0)	4 (16.7)	8 (33.3)	17 (44.7)	7 (36.8)	10 (52.6)
	c	5 (10.4)	3 (12.5)	2 (8.3)	6 (15.8)	4 (21.1)	2 (10.5)
	d	6 (12.5)	3 (12.5)	3 (12.5)	1 (2.6)	-	1 (5.3)
	Subtotal	**27 (56.3)**	**12 (50.0)**	**15 (62.5)**	**25 (65.8)**	**12 (63.2)**	**13 (68.4)**
II	a	2 (4.2)	-	2 (8.3)	-	-	-
	b	6 (12.5)	4 (16.7)	2 (8.3)	5 (13.2)	2 (10.5)	3 (15.8)
	c	4 (8.3)	3 (12.5)	1 (4.2)	-	-	-
	d	-	-	-	-	-	-
	Subtotal	**12 (25.0)**	**7 (29.2)**	**5 (20.8)**	**5 (13.2)**	**2 (10.5)**	**3 (15.8)**
III	a	-	-	-	-	-	-
	b	3 (6.3)	-	3 (12.5)	2 (5.3)	2 (10.5)	-
	c	-	-	-	1 (2.6)	-	1 (5.3)
	d	-	-	-	-	-	-
	Subtotal	**3 (6.3)**	**0 (0.0)**	**3 (12.5)**	**3 (7.9)**	**2 (10.5)**	**1 (5.3)**
IV	a	-	-	-	-	-	-
	b	4 (8.3)	4 (16.7)	-	1 (2.6)	1 (5.3)	-
	c	-	-	-	-	-	-
	d	-	-	-	-	-	-
	Subtotal	**4 (8.3)**	**4 (16.7)**	**0 (0.0)**	**1 (2.6)**	**1 (5.3)**	**0 (0.0)**
V	a	1 (2.1)	-	1 (4.2)	1 (2.6)	-	1 (5.3)
	b/d	1 (2.1)	1 (4.2)	-	1 (2.6)	-	1 (5.3)
	c	-	-	-	-	-	-
	Subtotal	**2 (4.2)**	**1 (4.2)**	**1 (4.2)**	**2 (5.3)**	**0 (0.0)**	**2 (10.5)**
VI	a	-	-	-	-	-	-
	b	-	-	-	1 (2.6)	1 (5.3)	-
	c	-	-	-	-	-	-
	d	-	-	-	-	-	-
	Subtotal	**0 (0.0)**	**0 (0.0)**	**0 (0.0)**	**1 (2.6)**	**1 (5.3)**	**0 (0.0)**
VII	a	-	-	-	-	-	-
	b/d	-	-	-	1 (2.6)	1 (5.3)	-
	c	-	-	-	-	-	-
	Subtotal	**0 (0.0)**	**0 (0.0)**	**0 (0.0)**	**1 (2.6)**	**1 (5.3)**	**0 (0.0)**
	Total	**48 (100)**	**24 (100)**	**24 (100)**	**38 (100)**	**19 (100)**	**19 (100)**

Table 6. The frequency of individual dog having a symmetrical branching pattern in the left and right subclavian arteries.

	Symmetry (%)	Asymmetry (%)
Male	9 (28.1)	23 (71.9)
Female	9 (34.6)	17 (65.4)
Total	**18 (31.0)**	**40 (69.0)**

Results

In this study, four new variations were found, they were type Va, Vb/Vd, VIb, and VIIb/VIId. Type V had had vertebral artery as the first branch, then costocervical and superficial cervical arteries arose together. Type Vb/Vd, the internal thoracic artery arose opposite either to the costocervical trunk or the superficial cervical artery while type Va the internal thoracic artery arose after the superficial cervical artery, but not opposite to the costocervical trunk. VIIb/VIId was described as vertebral artery is the first branch and then common trunk of costocervical and superficial cervical arteries, the internal thoracic artery arose opposite either to the costocervical trunk or the superficial cervical artery.The new patterns were found 4.4% of all dogs (Table 3) and 5.9% of Thai native dogs (Table 4). The frequency of branching patterns of all dogs in this study is shown in Table 3. The highest frequency of branching pattern in this study was type I (58.6%), specifically type Ib (32.8%), and it was statistically higher ($P < 0.01$) than other types. Type Ib was also the most common pattern for both left and right subclavian arteries.

The comparison between Thai native dogs and non-Thai dogs is shown in Table 2. For Thai native dogs, the main branching pattern was type I (60.5%), particularly type Ib (33.7%), and it was statistically higher ($P < 0.01$) than other types. Type 1b was dominant in both left and right subclavian arteries of Thai native dogs. In non-Thai dogs, the major pattern was also type Ib (30.0%), but it was not statistically different from IIb ($P > 0.05$). Notably, type Ib in non-Thai dogs was dominant on the right subclavian artery whereas the most common types of left subclavian were type Ic (20.0%) and IIb (20.0%).

The comparison between male and female Thai native dogs is shown in Table 5. Type Ib was the most common pattern in both male and female Thai native dogs. However, the occurrence of type Ib in female Thai native dogs was significantly higher ($P < 0.05$) than in the male (44.7% vs 25.0%). Notably, the left subclavian artery in male Thai native dogs had three common types (Ib, IIb and IVb, 16.7% each) whereas the common pattern in the females was only type Ib.

The similarity of branching pattern between left and right subclavian arteries is shown in Table 6. The occurrence of the asymmetric pattern (69.0% of dogs) of the subclavian artery was significantly higher ($P < 0.01$) than the symmetric pattern. Regarding to the sex, the asymmetric pattern was also more common in both male (71.9%) and female dogs (65.4%).

Discussion

The highest frequency of branching pattern in this study was type I (particularly type Ib) which was also the most common pattern for both left and right subclavian arteries. This finding is similar to previous report in the German Shepherd (Kim et al., 2010), but not the Greyhound who has the type Id as the most common pattern (Pols et al., 2016). This information will help veterinarian for understanding normal structure of subclavian artery of Thai native dog which is useful imaging diagnosis and surgery.

The occurrence of type Ib in female Thai native dogs was higher than the males, this finding is similar to the German Shepherd (Kim et al., 2010), but not the Greyhound (Pols et al., 2016). Initially, Kim et al. (2010) describe the anatomical variation of the subclavian artery using 4 main types (type I-IV) and 3 subtypes (a-c), 12 patterns in total. Type Ia to IIIc (9 patterns) are logically classified based on the level and appearance of the vertebral, costocervical, and superficial cervical arteries, but they describe type IV as all remaining case. Later, Pols et al. (2016) suggest that type IV should be logically described as the costocervical trunk arise before the vertebral artery, so they reclassify the pattern by replacing the old IV types with their new well described types, but they neglect type of IVa and IVc of Kim et al. (2010). In the present study, we included all variations found in previous studies and the present study and also illustrated the possibility of other variations that were not found yet. All variations were logically described and could be used for the future reference.

There are few disagreements between our study and the reference books used to study veterinary anatomy. Textbooks is reported that the internal thoracic artery usually arise simultaneously with the superficial cervical artery (subtype 'b'), and the vertebral artery is always the first branch of the subclavian artery (Ghoshal, 1975; Pasquini et al., 2003; Adam, 2004; Konig et al., 2007; Dyce et al., 2010; Evans and de Lahunta, 2010, 2013), this statement is inconsistent with our finding and recent studied (Kim et al., 2010; Pols et al., 2016) which found that only half of dogs have these variations. It is possible that the many textbooks relied on the old information (more than 10 years) and not updated with recent publications, this can cuase confusion with teachers and students.

In the present study, the common trunk of the vertebral artery and the costocervical trunk (type III) can be found approximately 4%, and the possibility that both arteries arose at the same level (type II) was 7%, this finding is consistent to the German Shepherd's study (Kim et al., 2010) but not the Greyhound (Pols et al., 2016) who has a type II pattern more than 32%. Moreover, the present study showed that the asymmetric pattern of the subclavian artery was more common than the symmetric pattern, which is comparable to previous studies (Kim et al., 2010; Pols et al., 2016), but it is not in accordance with the presentation in many textbooks (Pasquini et al., 2003; Adam, 2004; Konig et al., 2007; Dyce et al., 2010; Evans and de Lahunta, 2013).

In conclusion, the anatomical variation of branching patterns of the subclavian artery is unique in each type of dog. Type Ib is the most frequent pattern but being found less than half of the cases, and it is found in the female more often the male. The symmetric pattern of left and right subclavian arteries is uncommon. Many findings are inconsistent with many textbooks of canine anatomy. The knowledge of the subclavian artery variation is useful for veterinary education, imaging diagnosis, and surgical treatment.

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