

CHAPTER IV

RESULTS

1. The Pattern of the Thoracodorsal Artery in the Latissimus Dorsi Muscle

The thoracodorsal artery arose from the scapular artery and entered the deep surface of the latissimus dorsi muscle. The average length of the thoracodorsal artery, from the axillary artery to the inner surface of the muscle that the perforator disappeared, was 16.2 ± 2.0 cm (range: 12.0-21.8 cm) (Mean \pm S.D.) and the average diameter of the thoracodorsal artery at its bifurcation was 3.0 mm (range: 2.0-5.0 mm). The thoracodorsal artery gave three branches: the serratus, the medial and the lateral branch (Fig. 1). The serratus branch supply to the serratus anterior muscle. The medial branch supply to upper part of the latissimus dorsi muscle and lateral branch supply to middle part of the latissimus dorsi muscle. In addition there was a direct cutaneous branch originating from the thoracodorsal artery before the bifurcation.

The location of the bifurcation on the deep surface of the latissimus dorsi muscle, the number and percent of the bifurcation each location were reported in Table 1. In the majority of dissections (61.67%), the bifurcation located 1.8 ± 0.9 cm distal to the tip of the scapula.

In addition, the location of the bifurcation was 5.0 ± 1.5 cm (range: 2.0-8.8 cm) below the dome of the axilla. At this point there was constant bifurcation into a horizontal branch and a lateral branch.

The thoracodorsal artery divided into two branches on the deep surface of the latissimus dorsi muscle. The medial or the horizontal branch ran horizontally across the upper muscle parallel to the superior border 2.2 ± 0.6 cm from the edge of the muscle. The average length and diameter of the medial branch were 2.9 ± 0.8 cm and 2.0 ± 0.5 mm, respectively (Table 2). The lateral branch coursed longitudinally toward the iliac crest and parallel to the lateral border of the muscle remaining a mean distance of 1.7 ± 0.6 cm from the lateral margin of the muscle. The average length and diameter of the lateral branch were 8.9 ± 1.9 cm and 2.6 ± 0.4 mm, respectively (Table 2). Table 2 showed the lateral branch of the thoracodorsal artery was longest and largest vessel.

Table 1 The location related to the tip of the scapula and number of the bifurcation of the thoracodorsal artery

Location	Distance (cm)	Number	
Proximal to the tip of the scapula	1.9±0.7 (range: 1.0-3.5)	20	(33.3%)
Distal to the tip of the scapula	1.8±0.9 (range: 0.5-3.5)	37	(61.7%)
The same level with the tip of the scapula	-	3	(5.0%)
Total		60	(100%)

Table 2 The distance from free borders, diameter, and length of the lateral and medial branches of the thoracodorsal artery

Distance from free borders to arterial branches (cm)		Diameter of the origin at the bifurcation (mm)		Length of pedicle from its origin (cm)	
A	B	LB	MB	LB	MB
1.7±0.6	2.2±0.6	2.6±0.4	2.0±0.5	8.9±1.9	2.9±0.8
(0.5-3.5)	(0.5-4.0)	(1.9-3.7)	(1.2-3.5)	(5.5-15.5)	(1.3-5.5)

Abbreviations: A, distance from lateral border of muscle to lateral branch; B, distance from superior border of muscle to medial branch; MB, medial branch; LB, lateral branch

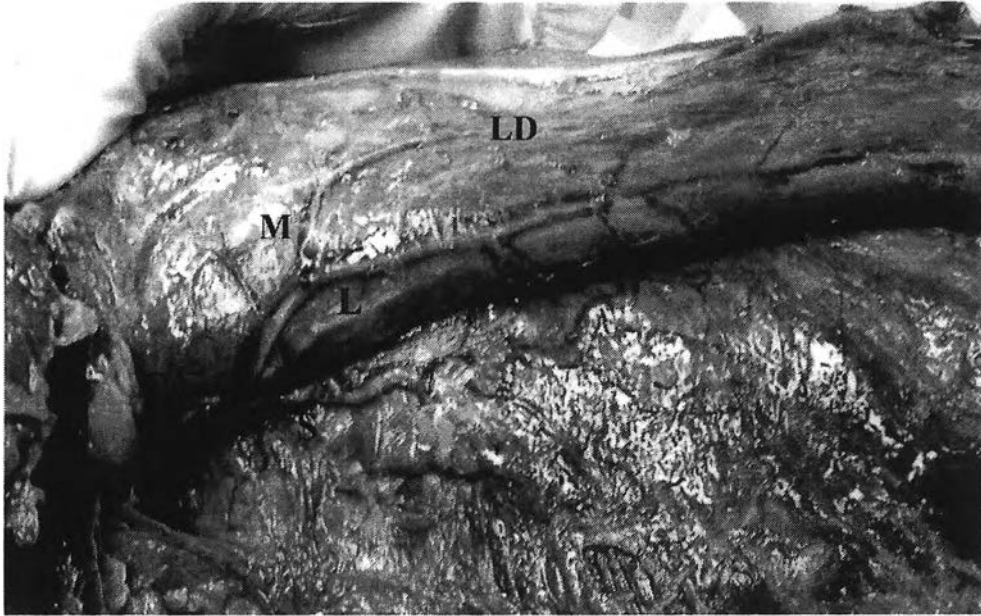


Figure 1. The thoracodorsal artery (TA) gave three branches on the latissimus dorsi muscle (LD): the serratus (S), the medial (M) and the lateral branch (L).

2. The Number of the Cutaneous Perforator

The number of the perforators of the lateral branch of the thoracodorsal artery was a total of 76 perforators larger than 0.5 mm. There was an average of 1.3 ± 0.6 perforators per flap (range: 1-3 perforators). The patterns of the perforator of the lateral branch were divided into three types. Type I, was found to have at one perforator of the lateral branch in 78.33 percent of specimens, type II and III were found to have two and three perforators in 16.67 and 5 percent, respectively (Table 3 & Fig. 2).

In addition, the number of the muscular branch of the lateral branch of the thoracodorsal artery was a total of 103 muscular branches. The muscular branch was 1.7 ± 0.8 branches per flap (range: 1-4 branches). The pattern and number of the muscular branch were shown in Table 4. The location, diameter and length of the first, the second, the third and the fourth muscular branches were demonstrated in Table 5.

In addition, the patterns of the perforators and the muscular branches of the lateral branch were classified into nine types (Table 6). Pattern I, having one perforator and one muscular branch, was mostly found in 38.33% (23 of 60 flaps). Pattern II, was found to have one perforator and two muscular branches in 30% (18 of 60 flaps). Pattern III, was found to have one perforator and three muscular branches 8.33% (5 of 60 flaps). Pattern VI, had two perforators and two muscular branches in 8.33% (5 of 60 flaps) (Fig. 3).

Table 3 The number and percent of each pattern of the perforators of the lateral branch

Pattern	Number	
1 st perforator only	47	(78.3%)
1 st ,2 nd perforators	10	(16.7%)
1 st ,2 nd &3 rd perforators	3	(5.0%)
Total	60	(100%)

Table 4 The number and percent of each pattern of the muscular branch of the lateral branch

Pattern	Number	
1 st muscular branch only	28	(46.7%)
1 st ,2 nd muscular branches	24	(40.0%)
1 st ,2 nd &3 rd muscular branches	6	(10.0%)
1 st ,2 nd ,3 rd &4 th muscular branches	2	(3.3%)
Total	60	(100%)

Table 5 Mean distance, diameter, and length of each muscular branch of the lateral branch

Muscular branch	Distance (cm)	Diameter (mm)*	Length (cm)**
1 st	7.8±2.0 (range: 3.7-11.9) ⁺	1.4±0.5 (range: 0.5-3.0)	2.6±1.4 (range: 0.7-9.7)
2 nd	1.8±0.8 (range: 0.8-3.7) ⁺⁺	1.4±0.4 (range: 0.6-2.0)	2.1±1.3 (range: 0.5-6.5)
3 rd	1.3±0.6 (range: 0.6-2.0) ⁺⁺⁺	1.1±0.2 (range: 0.8-1.5)	2.1±1.0 (range: 0.7-3.5)
4 th	1.5±0.8 (range: 0.9-2.0) ⁺⁺⁺⁺	1.5±0.5 (range: 1.1-1.8)	2.0±0.4 (range: 1.7-2.3)

Abbreviations: ⁺, distance from the dome of the axilla to the origin of 1st muscular branch; ⁺⁺, distance from the origin of the 1st muscular branch to 2nd muscular branch; ⁺⁺⁺, distance from the origin of the 2nd muscular branch to 3rd muscular branch; ⁺⁺⁺⁺, distance from the origin of the 3rd muscular branch to 4th muscular branch; *, at its origin; **, the origin to disappear to muscle.

Table 6 The patterns of the perforators and the muscular branches of the lateral branch

Pattern	Number		Number	
	Perforator	Muscular		
I	1	1	23	(38.3%)
II	1	2	18	(30.0%)
III	1	3	5	(8.3%)
IV	1	4	1	(1.7%)
V	2	1	3	(5.0%)
VI	2	2	5	(8.3%)
VII	2	3	2	(3.3%)
VIII	3	1	2	(3.3%)
IX	3	4	1	(1.7%)
	Total		60	(100%)

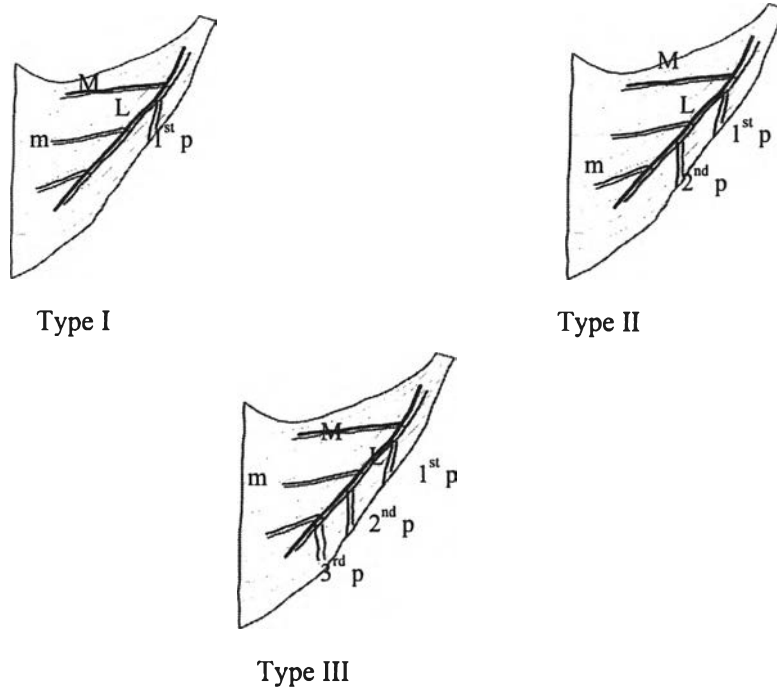


Figure 2. The patterns of the perforator of the lateral branch. M, the medial branch; L, the lateral branch; m, the muscular branch; p, the perforator.

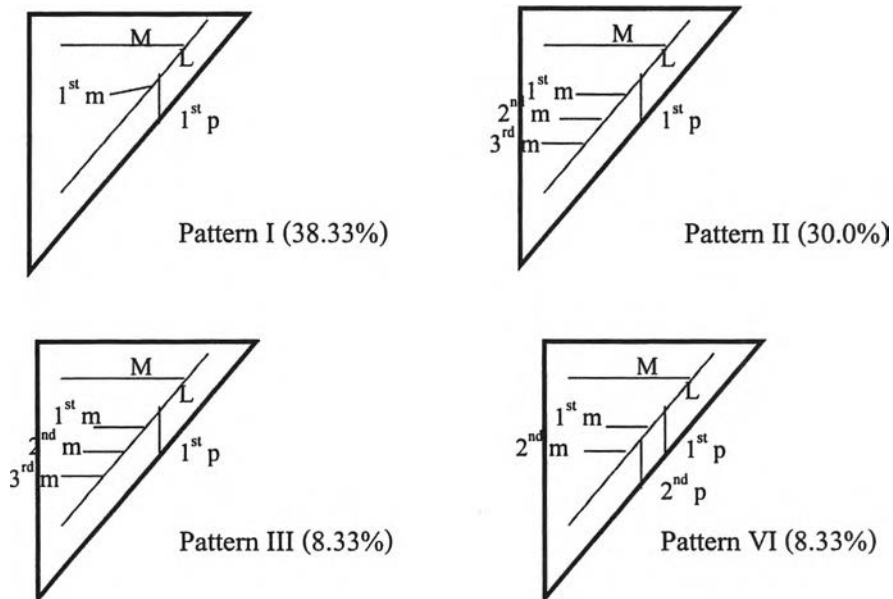


Figure 3. The most common pattern of the perforators and the muscular branches of the lateral branch. M, the medial branch; L, the lateral branch; m, the muscular branch; p, the perforator.

3. The Location of the Cutaneous Perforator of the Lateral Branch of the Thoracodorsal Artery

In this study, all perforating vessels arose from the lateral branch of the thoracodorsal artery, which supplied the skin-soft tissue. The perforator was oriented obliquely from the deep surface to the superficial (Fig. 4). In 100 percent of dissections, were found to have first perforator from the lateral branch of the thoracodorsal artery. The first perforator was always the largest from this vessel system, which measured from the dome of the axilla to its origin was 7.8 cm (range: 2.0-13.0 cm) and penetrating site to the muscle was 9.8 ± 2.6 cm (range: 4.1-14.8 cm) below the dome of the axilla (Fig.5). In 21.67 percent of dissections (13 of 60 flaps), the second perforator of the thoracodorsal artery arose 3.4 ± 2.1 cm distal to the origin of the first perforator and the penetrating site to the muscle was 11.5 ± 1.9 cm (range: 8.0-14.5 cm) (Fig. 6). The third perforator was found in 5 percent of dissections (3 of 60 flaps), originated 3.0 ± 1.6 cm from the origin of the second perforator and the penetrating site to the muscle was 12.8 ± 2.1 cm (range: 10.3-14.0 cm) (Fig.7). The mean of the diameter and the length for each perforator were demonstrated in Table 7.

In addition, average distances of all perforators (76 perforators) from the lateral branch of the thoracodorsal artery, measured from the dome of the axilla to the penetrating site to the muscle, were 10.2 ± 2.6 cm (range: 4.1-14.8 cm). The most perforators (67 of 76 perforators) were observed to penetrate the muscle for a distance of 7 to 14 cm distal to the dome of the axilla (Fig. 8) and closely located the lateral border of the muscle. The first perforator had 54 of 67 perforators which located this range (Fig. 9).

In addition, all perforators from the lateral branch of the thoracodorsal artery which measure from the dome of the axilla to its origin were 8.2 ± 2.5 cm (range: 2.0-13.2 cm). The most perforators located within 5.0-13.0 cm (Fig. 10).

In addition, all perforators from the lateral branch of the thoracodorsal artery which measure from the bifurcation to its origin were 3.3 ± 2.0 cm and located within 10.0 cm from the bifurcation (Fig. 11).

Table 7 Mean distance, diameter, and length of each perforator of the lateral branch

Perforator	Distance (cm)	Diameter (mm)*	Length (cm)**	Piece to muscle(cm)***
1 st	7.8±2.6 (2.0-13.0) ⁺	1.3±0.3 (0.7-2.0)	3.0±1.8 (0.7-11.5)	9.8±2.6 (4.1-14.8)
2 nd	3.4±2.1 (1.2-8.5) ⁺⁺	1.2±0.2 (1.0-1.6)	3.3±2.2 (1.0-8.5)	11.6±1.9 (8.0-14.5)
3 rd	3.0±1.6 (1.2-4.0) ⁺⁺⁺	1.0±0.1 (1.0-1.1)	2.4±0.5 (2.0-3.0)	12.8±2.1 (10.3-14.0)

Abbreviations: ⁺, distance from the dome of the axilla to the origin of 1st perforator; ⁺⁺, distance from the origin of the 1st perforator to 2nd perforator; ⁺⁺⁺, distance from the origin of the 2nd perforator to 3rd perforator; *, at its origin; **, the origin to piece to muscle; ***, from the dome of the axilla.



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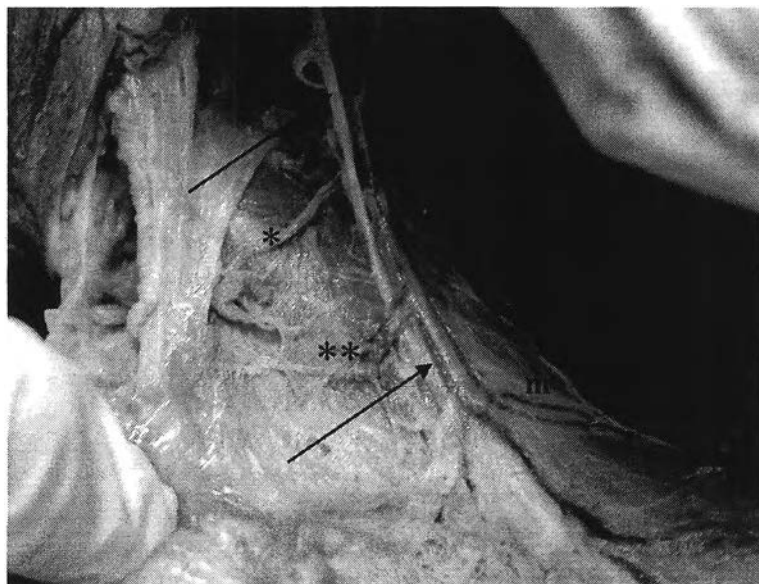


Figure 4. A preserved cadaver specimen of a latissimus dorsi muscle viewed from the deep surface.

The lateral border of the muscle has been retracted to expose the thoracodorsal artery and its cutaneous perforators; *, 1st perforator; **, 2nd perforator; m, muscular branch. The thoracodorsal nerve (top arrow) running accompany to the lateral branch of the thoracodorsal artery (bottom arrow)

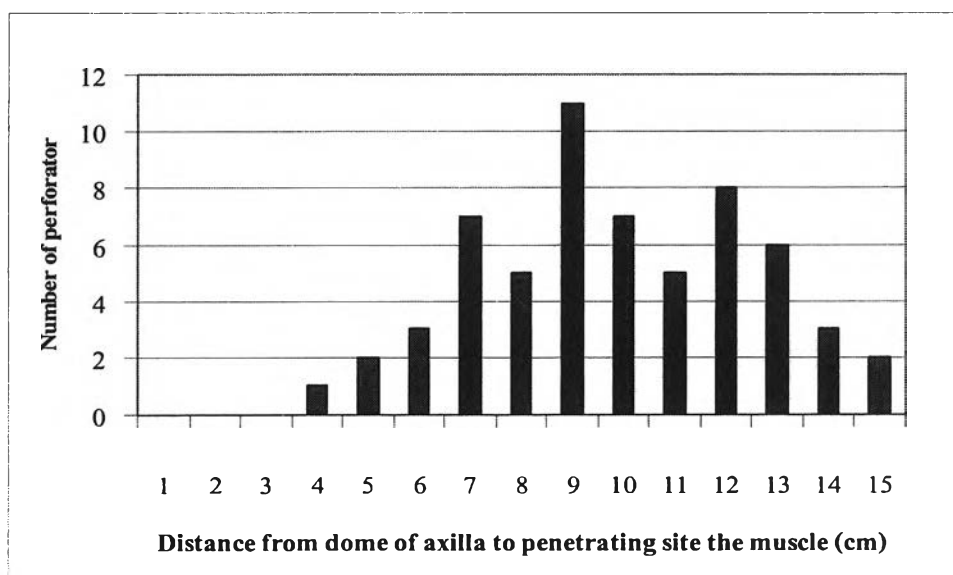


Figure 5. The location of the first cutaneous perforators which emerged from the muscle measured from the dome of the axilla as mean 9.8 ± 2.6 cm (range: 4.0-14.5 cm).

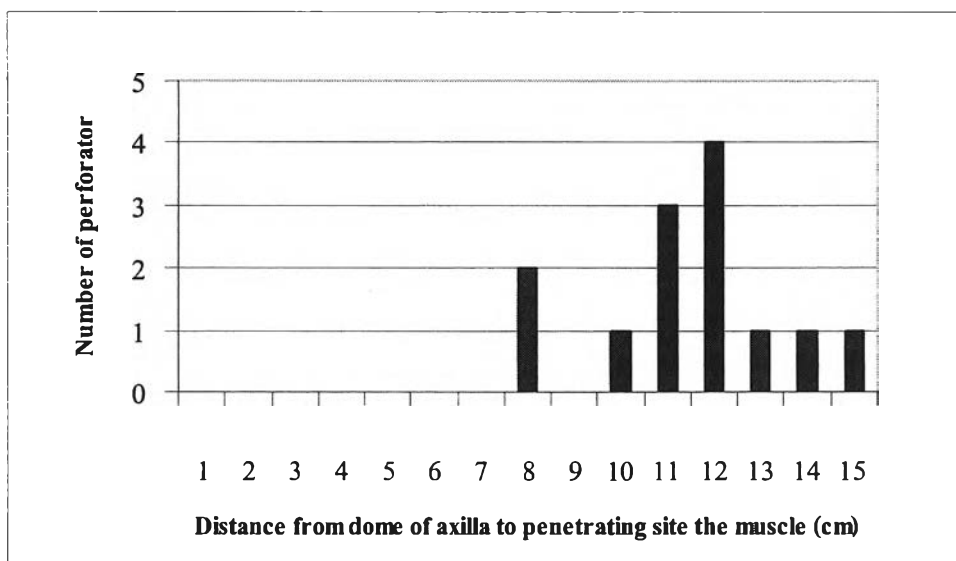


Figure 6. The location of the second cutaneous perforators which emerged from the muscle measured from the dome of the axilla as mean 11.6 ± 1.9 cm (range: 8.0-14.5 cm)

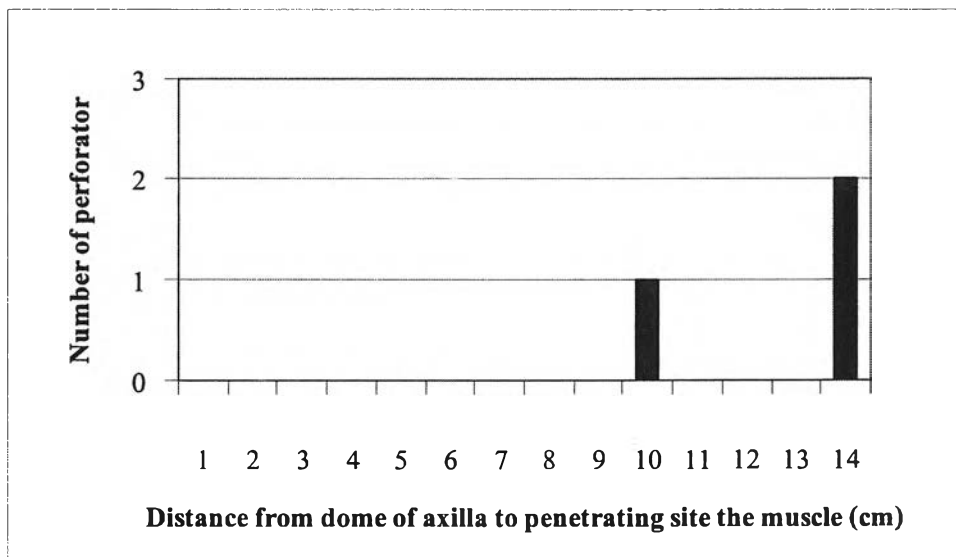


Figure 7. The location of the third cutaneous perforators which emerged from the muscle measured from the dome of the axilla as mean 12.8 ± 2.1 cm (range: 10.0-14.3 cm)

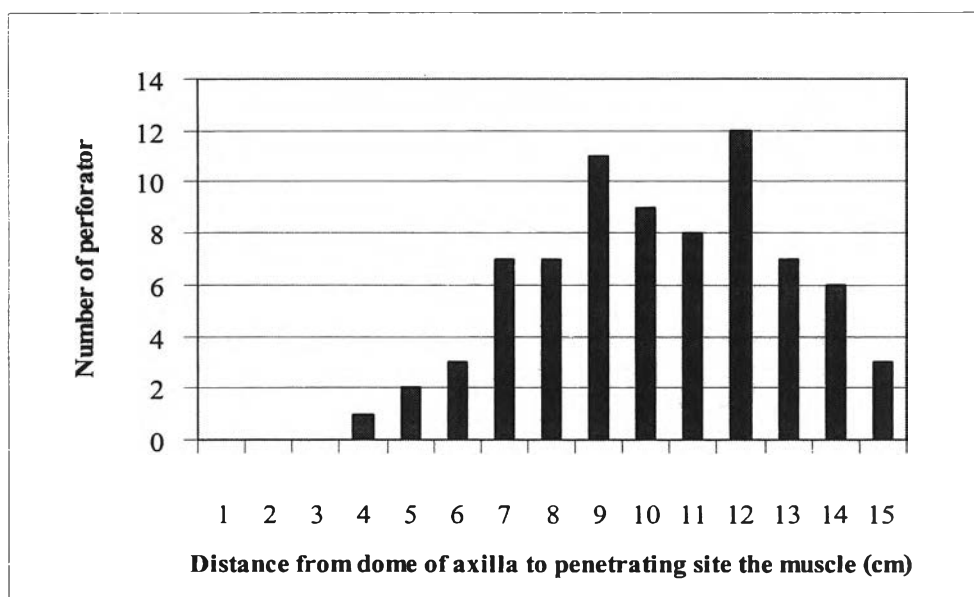


Figure 8. The location of all the cutaneous perforators which emerged from the muscle measured from the dome of the axilla as mean 10.2 cm. The most perforators (67 of 76 perforators) located within 7.0-14.0 cm from the dome of the axilla.

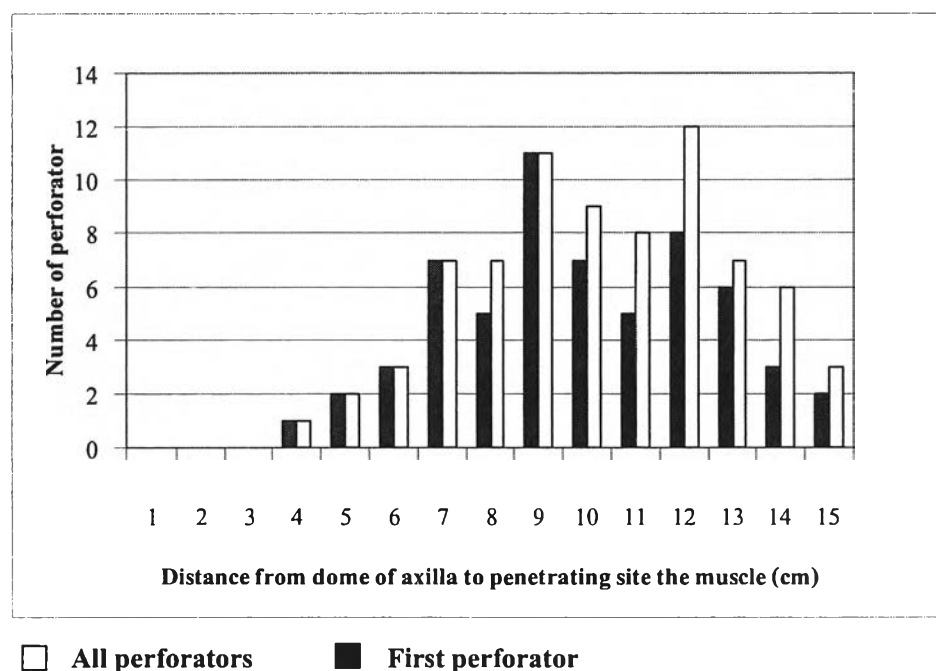


Figure 9. The location of the first perforator compared with all perforators. The first perforator which located within 7.0-14.0 cm from the dome of the axilla had 54 of 67 perforators.

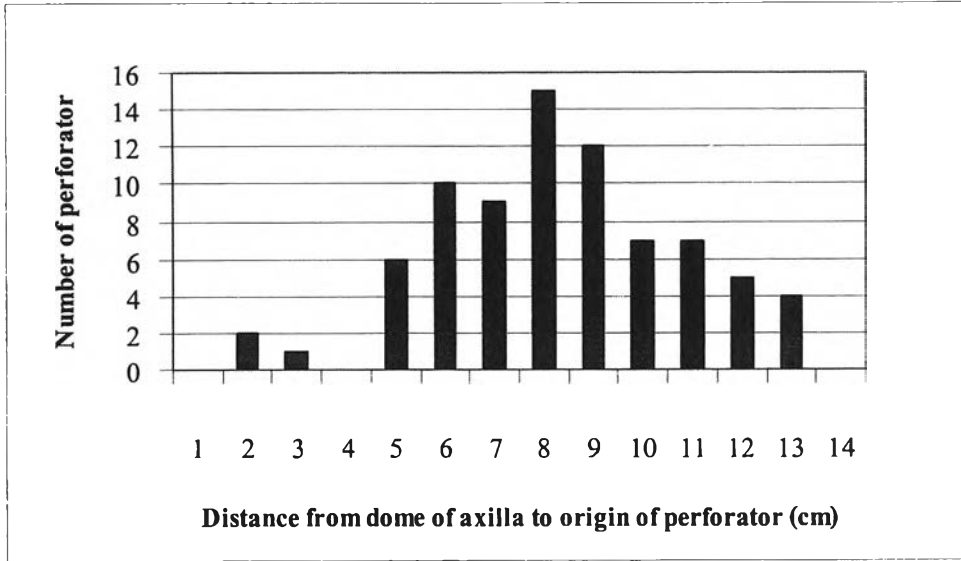


Figure 10. The locations of all perforators were measured from the dome of the axilla to the origin of the perforator. The perforators located within 2.0-13.0 cm.

Number of the perforator

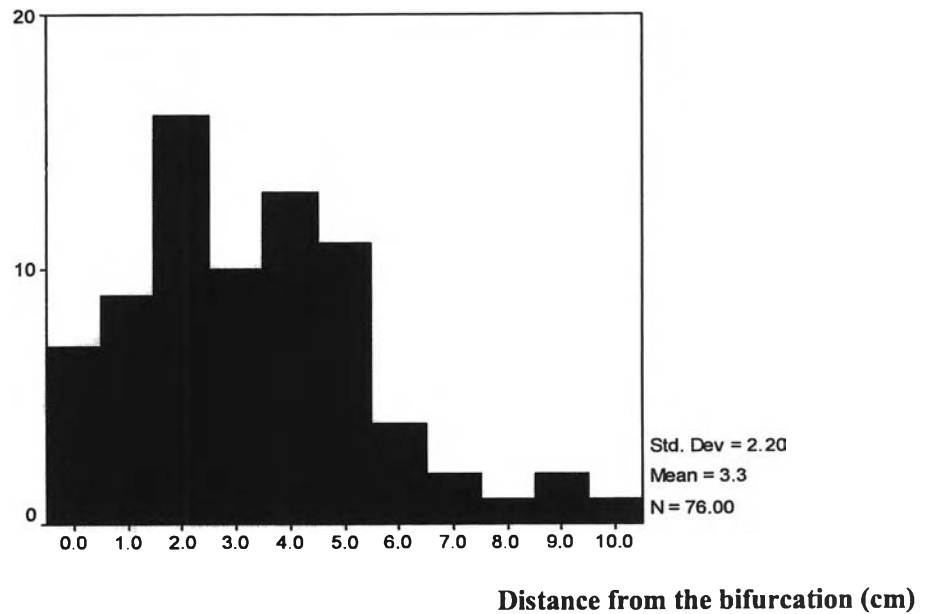


Figure 11. The locations of all the perforators were measured from the bifurcation to the origin of the perforator. The most perforators located within 10.0 cm.

4. The Relationship of the Nerve and Vessels to the Muscle

The innervation of the latissimus dorsi muscle was through the thoracodorsal nerve. We observed this nerve in all dissections (100%). The thoracodorsal nerve continued to course along the artery and distributes their branches with arterial branches. The thoracodorsal nerve laid deep to the artery related to the deep surface of the latissimus dorsi muscle. The diameter of the thoracodorsal nerve at its bifurcation was 1.8 ± 0.4 mm (range: 1.1-2.7 mm). The locations of the thoracodorsal nerve come pare were reported in Table 8. In the majority of the dissections (58.33%), the thoracodorsal nerve laid lateral and superficial location to the artery (Fig. 8). In 18.33 percent of dissections, the thoracodorsal nerve was found in a medial and superficial location relative to the artery.

5. The Direct Cutaneous Perforator of the Thoracodorsal Artery

The direct cutaneous perforator originated directly from the thoracodorsal artery proximal to the bifurcation in 93.3% (56 of 60 flaps) (Fig. 9). This perforator made its way around the free lateral border of the latissimus dorsi muscle to reach subcutaneous fat and skin. In the majority of the dissections (42 of 56 flaps), the direct cutaneous perforator located 1.5 ± 0.7 cm proximal to the bifurcation and 3.6 ± 1.5 cm (range: 0.5-6.7 cm) from the dome of the axilla to its origin. In 9 of 56 flaps were 1.5 ± 1.1 cm distal to bifurcation and 5 of 56 flaps were equal to the bifurcation (Table 9).

Table 8 The location of the thoracodorsal nerve

Location	Number	
Lateral / superficial to vessel	35	(58.3%)
Lateral / deep to vessel	8	(13.3%)
Medial / superficial to vessel	11	(18.3%)
Medial / deep to vessel	6	(10.0%)
Total	60	(100%)

Table 9 The location of the direct cutaneous perforator of the thoracodorsal artery

Location	Distance (cm)	Number	
Proximal to the bifurcation	1.5±0.7 (range: 0.6-3.0)	42	(75.0%)
Distal to the bifurcation	1.5±1.1 (range: 0.7-4.0)	9	(16.1%)
The same level with the bifurcation	-	5	(8.9%)
Total		56	(100%)



Figure 12. The relationship between the thoracodorsal nerve (right arrow) and the thoracodorsal vessel (left arrow).

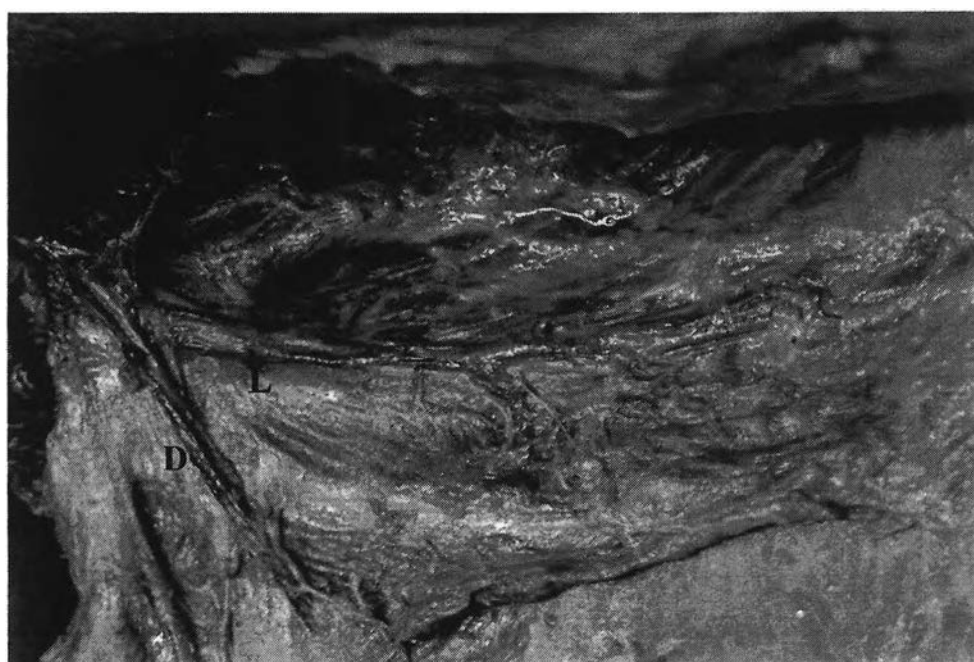


Figure 13. The direct cutaneous perforator (D) of the thoracodorsal artery (TA). S, the serratus branch; L, the lateral branch.