Vet.Med.J.,Giza. Vol.53, No.3. (2005): 831-854.

MORPHOLOGIC AND ANGIOGRAPHIC STUDIES ON THE VASCULAR PATTERNS OF SOME MUSCLES OF THE THORACIC LIMB IN DOGS

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Received: 17. 4. 2005
Accepted: 5. 7. 2005

SUMMARY

The current investigation was performed on ten adult clinically healthy dogs of both sexes to study the vascular patterns of some muscles of the thoracic limbs and to identify the most suitable muscles to be used as muscle flaps in reconstructive surgery. The obtained results gave a clear picture about the source, site of entrance and intramuscular distribution of the arterial pedicles. It was concluded that the ulnar and humeral heads of the flexor carpi ulnaris, extensor digitorum lateralis and extensor carpi ulnaris muscles were the most suitable, reliable and recommended muscles to be used as muscle flaps in the field of reconstructive surgery. Other muscles, owing to their functional importance, inaccessibility or unfavourable vascular patterns, would not become suitable for use as muscle flaps.

INTRODUCTION

Muscle flaps play an important role to achieve wound healing, compared to the use of skin flaps, enhance neovascularization, increase oxygen tension within the wound and deliver components of the host defence mechanism as well as less susceptible to infection. However, knowledge of the vascular anatomy of the muscle to be transferred is of primary importance that allows the reconstructive surgeon a mean of recognizing the muscle with greatest margin of safety for use in the management of the difficult defects such as large and complex wounds, chronic osteomylitis and osteoradionecrosis (Chambers, Purinton, Allen and Moore, 1990; Purinton, Chambers and Moore, 1992; Arnold, Lovich and Pairolero, 1994; Degner, Walshaw, Arnoczky, Smith, Patterson, Degner, Hamaide and Rosenstein, 1996 and Calfee, 2002).

Microvascular free muscle transfer is based on definable regions of muscle perfused by a single nutrient artery and a satellite vein (Mathes and Nahai, 1981) and this highly successful technique has been used for reconstruction of distal extremity wounds in dogs (Khouri and Shaw, 1989).

Therefore, the present work was carried out to identify the vascular pedicles in some muscles of the thoracic limbs of dogs, in an attempt to classify the vascular patterns of major muscles according to the system described by Mathes and Nahai (1981) and Chambers et al., (1990) . Also, it was an attempt to identify muscles that would be most suitable, safe and reliable for use as muscle flaps in reconstructive surgery.

MATERIALS AND METHODS

Work was conducted on ten adult clinically healthy dogs of both sexes. The animals were anaesthetized by induction of a general anaesthesia, (Hall, Clarke and Trim, 2001), then they were exsanguinated by shedding blood from the common carotid artery. The cadavers were injected with colored radio-opaque material (red lead oxide suspended in vegetable turpentine oil, 1:1 weight: volume) via the common carotid artery under a suitable hand pressure till increased resistance was felt. Angiography of the axillary artery and its main branches was performed to identify the general vascular pattern of the thoracic limbs.

The injected dogs were kept in a refrigerator for 48 hours, and then the injected limbs of five dogs were subjected to a thorough gross dissection to obtain a clear picture about the outline of the vascular anatomy of the muscles under investigation. Moreover, some of the major muscles of the thoracic limbs of the other five dogs were then resected and radiographed independently to demonstrate the site of entrance and intramuscular distribution of the different vascular pedicles of each muscle. Determination of the vascular pattern of the studied muscles was adopted according to Mathes & Nahai (1981) in human and Chambers et al. (1990) in dogs.

Nomenclature was adopted according to the Nomina Anatomica, Embrylogica and Histologica Veterinaria (1994)

RESULTS

M. deltoideus: (Figs. 1A / 1& '1 and 1B / 2&'2)

The scapular part of the deltoideus muscle received a large branch of the caudal circumflex humeral branch of the subscapular artery. This large branch entered the deep face of the muscle, near its caudodistal border (Fig. 7 / 1) and gave off multiple pedicles that supplied the distal two-thirds of that part of the deltoideus muscle. However, the proximal third of the scapular part of the muscle was vascularized by a smaller branch from the subscapular artery that entered the muscle near the cranial border of its proximal third (Fig. 7 / 2). Strong and extensive anastomoses existed between the rami of these two branches. The acromial head of the deltoideus muscle was supplied by three separated branches detached from the caudal circumflex humeral artery. These branches entered the deep face of such part of the muscle (Fig. 7 / 1) to supply its distal two-thirds as well as its caudal border. Moreover, two additional small branches from the subscapular artery entered at the cranial border of the upper part of the acromial head and supplied the proximal third of that part of the deltoideus muscle (Fig. 7 / 2). Fine intramuscular anastomoses were seen between these different vascular pedicles. Moreover, a very small pedicle was seen at the cranial border of the deep face of the distal part of the acromial head. Such pedicle was detached from the suprascapular branch of the superficial cervical artery (Fig. 7 / 3).

M. infraspinatus: (Fig. 1B / 12)

The infraspinatus muscle received its blood supply primarily via three pedicles (proximal, middle and distal) with extensive intramuscular anastomoses between them. The proximal pedicle was the largest and was detached from the subscapular artery (Fig. 8 / 1). It entered the caudal border of the muscle just proximal to its mid pint, proceeded proximally supplying the caudal border of the muscle, then swerved to terminate at its cranial border supplying the proximal third of the muscle. The middle pedicle was much smaller than the preceding one and was also detached from the subscapular artery. It entered the muscle about the middle of its caudal border and ramified into the middle third of the muscle belly. The distal smallest pedicle was provided by the suprascapular branch of the superficial cervical artery and supplied the distal third of the muscle (Fig. 8 / 3). Moreover, the caudal circumflex humeral artery contributed in the vasculature of the distal part of the muscle by a minor branch that entered the muscle at its caudal border (Fig. 8 / 2).

M. teres major: (Fig. 3 / 5)

The major arterial supply to the teres major muscle was contributed via two sources. A major pedicle came from the subscapular artery during its course between the Mm. subscapularis and teres major (Fig. 3 / 13). It entered the deep face of the muscle approximately at the distal third of its cranial border and gave off several branches that supplied the cranial border and nearly the distal two-thirds of the muscle belly (Fig. 9 / 1). Another major pedicle from the thoraco-dorsal branch of the subscapular artery ramified into the caudal border and proximal third of the muscle belly (Fig. 9 / 2).

M. teres minor:

The caudal circumflex humeral branch of the subscapular artery detached two nearly equal pedicles that entered the cranial and caudal borders of the teres minor muscle at about its mid-belly. The two pedicles provided arterial vasculature to the whole muscle (Fig. 10 / 1 & 2), through the intramuscular anastomoses that occurred between their rami.

M. biceps brachii: (Figs. 3 / 20, 4 / 3 & 5A / 2)
The muscle belly was supplied by two major separate pedicles, proximal and distal. The proximal major pedicle was detached from the cranial circumflex humeral branch of the brachial artery. It entered into the deep face of the muscle proximally, and vascularized the proximal half of the muscle (Fig. 11 / 1). On the other hand, the second major pedicle was detached from the superficial brachial branch of the brachial artery, entered the distal portion of the muscle to ramify within its distal half (Fig. 11 / 2).

M. brachialis: (Fig. 1B / 4)
The proximal and distal ends of the brachialis muscle gained their vasculature from two small pedicles derived from the caudal circumflex humeral branch of the subscapular artery and the transverse cubital branch of the brachial artery, respectively (Fig. 12 / 1&3). The remaining major part of the muscle belly was supplied by two large pedicles given off from the collateral radial branch of the caudal circumflex humeral artery (Fig. 12 / 2).

M. triceps brachii: (Figs. 1A / 2 & '2, 1B / 3 & ' 3 and 3 / 21 & 22)

The triceps brachii muscle was supplied by four major pedicles; the subscapular, caudal circumflex humeral, deep brachial and collateral ulnar arteries, in addition to two small pedicles from the ulnar and cranial interosseous arteries. The subscapular branch arose from the axillary artery near the scapular attachment of the long head of the triceps brachii muscle and coursed in the space between the long and medial heads of the muscle and was distributed into the proximal parts of these two heads (Fig. 13 / 1). The caudal circumflex humeral branch of the subscapular artery (Fig. 6 / 'S) , passed transversely in a semicircular curve across the long and medial heads of the muscle and gave off several small branches to the middle portions of such two heads (Fig. 13 / 2). Extensive anastomoses between the branches of the caudal circumflex humeral pedicle and those of the subscapular pedicle were apparent. The deep brachial branch of the brachial artery (Fig. 6 / D) proceeded distally in the space between the long and medial heads of the triceps brachii muscle (Fig. 13 / 3). It gave off branches to the distal part of the medial head and also provided a large branch to the distal third of the long head. The vessel then terminated into two nearly equal branches that ramified in the upper half of the lateral head of the muscle. Strong anastomoses were seen between the branches of the deep brachial pedicle and those of the caudal circumflex humeral one. The collateral ulnar branch of the brachial artery (Fig. 6 / U) supplied several rami to the lower part of the long head of the triceps brachii muscle (Fig. 13 / 4). Anastomoses were established between the rami of the collateral ulnar pedicle and those of the preceding two pedicles. It might be added, however, that two small additional pedicles were also contributed to the vascularization of the lateral head of the muscle. One of these two pedicles arose from the ulnar branch of the common interosseous artery could be demonstrated at the proximal caudal part of the lateral head, close to its junction with the long head. It supplied such part of the lateral head of the muscle (Fig. 13 / 5) and anastomosed with the preceding collateral ulnar pedicle. The other pedicle was detached from the cranial interosseous branch of the common interosseous artery (Fig. 13 / 6). It supplied the distal part of the lateral head of the muscle and established weak anastomoses with the deep brachial pedicle.

M. tensor fasciae antebrachii: (Figs. 3 / 23 & 4 / 6)

The tensor fasciae antebrachii muscle in the dog appeared strap-like and was supplied mainly by a major pedicle detached from the thoracodorsal branch of the subscapular artery (Fig. 14 / 1). This pedicle entered the muscle through the proximal part of its cranial border and gave off intramuscular ramifications that vascularized the proximal two-thirds of the muscle belly. Moreover, another very delicate pedicle could be detected to arise from the collateral ulnar branch of the brachial artery and supplied the distal third of the muscle (Fig. 14 / 2).

M. flexor carpi radialis: (Fig. 4 / 10)

Three segmental pedicles (proximal, middle and distal) shared in the vasculature of the flexor carpi radialis muscle with consistent intramuscular anastomoses between these different pedicle systems. The proximal pedicle that supplied the proximal third of the muscle was detached from the recurrent ulnar branch of the brachial artery (Figs. 6 / U and 15 / 1). However, in few cases, this part of the muscle was supplied by a pedicle from the collateral ulnar branch of the brachial artery. The middle pedicle was given off from the deep antebrachial artery and vascularized the middle third of the muscle (Fig. 15 / 2). This latter artery arose primarily from the median artery and sometimes from the brachial artery. The distal pedicle was provided from the radial branch of the median artery and vascularized the distal third of the muscle up to its musculo-tendinous junction (Figs. 6 / R & 15 / 3).

M. flexor digitorum superficialis: (Figs. 4 / 12 & 5B / 3)

The muscle was supplied by three minor pedicles. The first of these pedicles was detached from the recurrent ulnar branch of the brachial artery (Fig. 6 / N), entered the deep face of the proximal end of superficial digital flexor muscle and travelled distally to supply its proximal third (Fig. 16 / 1). The second pedicle was given off from the deep antebrachial branch of the median artery and pierced through the deep face of the muscle to vascularize its middle third (Fig. 16 / 2). The distal third of the muscle received its blood supply in most cases from a small pedicle detached from the caudal interosseous branch of the common interosseous artery (Fig. 16 / 3). There were weak anastomoses between these different pedicle systems.

M. flexor carpi ulnaris:

The ulnar head of the flexor carpi ulnaris muscle (Figs. 2 / 9 & 4 / 22) gained its vasculature via two minor pedicles. The proximal of these two pedicles was detached from the collateral ulnar branch of the brachial artery. It proceeded through the deep face of the proximal end of the muscle and, then passed distally to ramify in the texture of the proximal fourth of the muscle (Fig. 17 / 1). The second pedicle was given off from the ulnar branch of the common interosseous artery. It entered the deep face of the muscle, at about its mid-belly, then it passed proximally and distally supplying the rest of the muscle up to the musculo-tendinous junction (Fig. 17 / 2). Weak fine anastomoses were seen between both pedicles.

In the majority of dissected specimens, the humeral head of the flexor carpi ulnaris muscle was observed to receive its arterial supply via one major and four minor pedicles. The proximal minor pedicle was detached from the recurrent ulnar branch of the brachial artery and entered the deep face of the proximal third of the muscle, close to its cranial border (Fig. 18 / 1). On the other hand, the other two minor pedicles originated from the lateral aspect of the ulnar branch of the common interosseous artery. They entered the muscle, at its caudal border, and supplied, nearly, the distal two-thirds of the muscle belly (Fig. 18 / 3). The major pedicle was derived from the deep antebrachial branch of the median artery, entered the cranial border of the muscle and also supplied about the distal two-thirds of the muscle (Fig. 18 / 2). In such way, the ulnar and deep antebrachial pedicles shared in the vasculature of the distal two-thirds of the muscle.

M. extensor carpi radialis: (Figs. 1B / 10, 2 / 5, 4 / 9 and 5 A / 1)

The major arterial supply of the extensor carpi radialis muscle was represented by two large pedicles provided by the transeverse cubital branch of the brachial artery (Fig. 6 / T). Both pedicles usually entered independently through the deep face of the proximal fourth of the muscle and passed along with the muscle fibers supplying the proximal third to two-thirds of the muscle belly (Fig. 19 / 1). However, a proximal minor pedicle was demonstrated to arise from the collateral radial branch of the caudal circumflex humeral artery and supplied the proximal end of the muscle (Fig. 19 / 2). Moreover, another minor pedicle detached from the caudal interosseous branch of the common interosseous artery was detected at the musculo-tendinous junction (Fig. 19 / 3).

M. extensor digitorum communis: (Figs. 2 / 6 & 4 / 8)

Two sources of arterial supply contributed in the vasculature of the common digital extensor muscle. A major pedicle provided by the cranial interosseous branch of the common interosseous artery which entered the deep surface of the muscle approximately at the mid-belly (Fig. 20 / 1). It gave off proximal and distal intramuscular rami that supplied the greater part of the muscle belly. The transverse cubital branch of the brachial artery shared in the arterial supply of the muscle by a much smaller pedicle than the preceding one. Such pedicle entered the common digital extensor muscle, at its junction with the extensor carpi radialis muscle, and supplied the proximal fourth of the former muscle (Fig. 20 / 2). Weak intramuscular anastomoses occurred between both pedicle systems of the muscle.

M. extensor digitorum lateralis: (Fig. 2 / 7)

The lateral digital extensor muscle received its arterial supply via four minor pedicles. Two of these pedicles were given off from the cranial interosseous branch of the common interosseous artery. They entered the deep face of the muscle and supplied the proximal half of the muscle (Fig. 21 / 1). The other two pedicles were of a much smaller caliber and came from the caudal interosseous branch of the common interosseous artery and supplied the distal half of the muscle (Fig. 21 / 2).

M. extensor carpi ulnaris: (Fig. 2 / 8)

Two pedicles; one major pedicle and another minor one were observed to vascularize the extensor carpi ulnaris muscle. The major pedicle was detached from the cranial interosseous branch, entered the deep surface of the proximal fourth of the muscle (Fig. 22 / 1)where it gave off ascending and descending intramuscular ramifications that supplied the proximal half of the muscle. The minor pedicle was provided by the caudal interosseous branch, entered the muscle about its middle and travelled distally to supply approximately the distal half of the muscle (Fig. 22 / 2). The rami of the second pedicle finely anastomosed with those of the major pedicle.

DISCUSSION

An individual muscle must fulfill certain anatomic requirements before consideration for use in free tissue transfer. Muscles must have an expendable function, be easily accessible, have a reliable vascular pedicle, and produce minimal donor site morbidity following removal. If a muscle to be used in free tissue transfer does not have an expendable function, then it must have surrounding musculature to perform its function following removal from the donor site. Additional requirements include; the vascular pedicle should be a single artery and vein; the length of the pedicle should be at least 1.0 cm, the arterial and venous diameters of at least 0.5 mm or greater and an appropriate vascular distribution (Mathes and Nahai, 1982; Chambers et al. 1990; Gregory, Gourley, Koblik, Snyder and Ilkiw, 1992; Nicoll , Fowler, Remedios, Clapson and George, 1996; Ocal, Mutus and Alpak , 1996; Calfee, 2002 and El-Daharawy, 2004).

Mathes and Nahai (1981) in human designed a scheme for the vascular pattern of the muscles that ranks the various pedicles in regard to muscle survival following its transplantation. Accordingly, there are five defined vascular patterns for muscles. Type I, muscles receive blood flow from one major vascular pedicle and the entire muscle can be transferred based on that pedicle. Type II, muscles have one or more dominant pedicles entering at the muscle's insertion or origin with additional minor pedicles entering the muscular body. Transfer of type II muscles can be performed based on the major vascular pedicle following ligation of the minor pedicles. Type III, muscles have two major vascular pedicles that each supplies approximately 50% of the muscular blood flow. Transfer of type III muscles can be based on either of the major pedicles but a portion of the muscle will routinely die if the entire muscle is transferred. Type IV, muscles have no major vascular pedicle but are perfused by several minor pedicles. Type IV muscles, therefore, have very limited application in free tissue transfer. Type V, muscles have one major vascular pedicle but receive additional blood supply from minor segmental vessels. The entire muscle will survive if either the major vascular pedicle or the segmental blood supply is maintained. This scheme is considered suitable for application in the current work. Therefore, informations about the different vascular pattern systems of the muscles are of great importance in determining and selecting the most suitable muscle for transplantation in the treatment of large wounds.

The muscles undertaken in the current work from the thoracic limbs of dogs are richly supplied with collaterals given off from the main neighboring vessels. Such results are mostly simulated that recorded by Ghoshal (1975); Schummer, Wilkens, Vollmerhaus and Habermehl (1981); Shively

(1987); Purinton, et al. (1992); Evans (1993); Dyce, Sack and Wensing (2002) and Boyd (2001).

M. deltoideus:

The vascular pattern of both scapular and acromial heads of the deltoideus muscle could be described as being of type II. The distal portion of the scapular head of the deltoideus muscle, as it had a single long caudal circumflex humeral pedicle in addition to its superficial location might be a good candidate as a muscle flap. However, purinton et al. (1992) stated that the short length of the caudal circumflex humeral pedicle will limit rotation of the distal portion of the muscle in dogs. The authors also added that, the use of the proximal portion of the scapular head might be limited due to its close association with the infraspinatus muscle.

M. infraspinatus:

The arterial pattern of the infraspinatus muscle could be categorized as being of type II. Only the proximal third of the infraspinatus muscle may be useful as muscle flap based on the large dominant subscapular pedicle, however, the rest of the muscle is not readily accessible because of the overlying deltoideus muscle and supplied by minor pedicles. Similar findings were observed by purinton et al. (1992).

M. teres major:

As given by Purinton et al. (1992), the serial supply (type IV) from the subscapular artery probably makes the teres major muscle undesirable for use as a muscle flap. However, in view of the present study, the muscle could be classified, according to Chambers et al. (1990) in dog, as being of type III vascular pattern. Therefore, the proximal portion might be used for local rotation flap based on mobilization of the thoracodorsal pedicle, but the short length of such pedicle will limit this rotation. Moreover, the close association of the distal portion of the muscle with the latissimus dorsi might render it unuseful for rotation.

M. teres minor:

Our results revealed that the vascular pattern of such muscle described mostly to be type III. Although, this muscle was vascularized by a suitable vascular pattern to be used as muscle flap according to Mathes and Nahai (1981) and Chang and Mathes (1982) in human, who mentioned that the muscle in type III generally survives and has two arcs of rotation based on their dominant vascular pedicles, yet, the teres minor muscle in the present work is inaccessible to be used as muscle flap because of its location deep to the deltoideus muscle.

M. biceps brachii:

The biceps brachii muscle is considered as one of the cranial brachial muscles that possess a functional importance in extending the shoulder joint and flexing the elbow joint (Clair, 1975). The vascular pattern of the muscle described here belonged to type III, similar to that recorded by Purinton et al. (1992) in 45 % of dogs. The latter authors discovered that in the remaining 55 % of the specimens, the vascular pattern was of type II as the muscle receives two dominant pedicles in addition to a small one. However, the bicipital artery pedicle to the middle third of the muscle found by these authors was not discovered in our specimens. It is also suggested that owing to the functional importance of the biceps brachii muscle, it would be unsuitable for use as a muscle flap.

M. brachialis:

The brachialis muscle is also one of the cranial brachial muscles, lies deep to the biceps brachii and it flexes the elbow joint (Clair, 1975). In the present study, the vascular pattern of this muscle mostly resembled type II. However, since the muscle was deeply situated and thus inaccessible, it would not be recommended to use such muscle as a muscle flap. This result agreed with that recorded by Mathes and Eshima (1990) in human and Nicoll et al. (1996) in cats, who mentioned that the muscle should be easily accessed surgically and muscle elevation should result in minimal donor site morbidity.

M. triceps brachii:

The triceps brachii muscle is considered as one of the most important caudal brachial muscles that extends the elbow and also its long head flexes the shoulder joint (Clair, 1975). Beside this important function, the triceps brachii muscle of dog possesses a complex unfavourable vascular pattern; therefore, it would be unsuitable to use such muscle as a muscle flap. Moreover, the vascular pattern of the muscle as revealed in the current study was mostly of type II, a result which confirmed the conclusion made by purinton et al. (1992). Furthermore, the latter authors also stated that the distal end of the medial head might have limited use based on mobilization on the collateral ulnar pedicle. However, such pedicle of the medial head was not discovered in our study.

M. tensor fasciae antebrachii:

Like the preceding muscle, the tensor fasciae antebrachii muscle is one of the caudal brachial muscles that extend the elbow and flex the shoulder joint (Clair, 1975). The vascular pattern of the muscle in our study belonged mostly to type II. However, the vascular pattern of such muscle may yield usable pedicle specially the proximal half to two-thirds of the muscle which might be mobilized around the thoracodorsal pedicle. This result agreed with that mentioned in human and cats by Mathes and Eshima (1990) and Nicoll et al. (1996), who recommended that the flap should have an expendable function.

M. flexor carpi radialis:

According to Mathes and Nahai (1981) in human and Chambers et al. (1990) in dog, the vascular pattern of the flexor carpi radialis muscle revealed in the current investigation mostly resembled type IV, where division of more than 2 or 3 of serially adjacent pedicles in this type will result in some muscle necrosis. Therefore, the flexor carpi radialis would not be recommended as flaps.

M. flexor digitorum superficialis:

The muscle could represent type IV vascular pattern. Despite the accessibility of the superficial digital flexor muscle, yet, its use as a muscle flap will be unsuccessful. This is due to its highly important functions and to the sharing of its vessels with the deep digital flexor muscle. Such findings confirmed that reported by Purinton et al. (1992) in dogs.

M. flexor carpi ulnaris:

Since two minor pedicles enter the ulnar head of the flexor carpi ulnaris muscle with weakly intramuscular anastomoses between them occurring on the deep surface, therefore, the muscle could be classified as being of type IV vascular pattern. According to Mathes and Nahai (1981) in human and Chambers et al. (1990) in dogs, type IV muscles have very limited application in free tissue transfer, and therefore, the flexor carpi ulnaris muscle would not be recommended as a muscle flap.

The vascular pattern of the humeral head of the flexor carpi ulnaris muscle appeared to be type II. However, rotation of the distal half of the muscle around the deep antebrachial pedicle may be useful as a muscle flap. Similar observations were recorded by Purinton et al. (1992) but mobilization of this part of the muscle according to those authors was around the caudal interosseous artery. The authors also added that this flap may be useful for reconstruction of severe injuries to the manus.

Mm. extensor carpi radialis and extensor digitorum communis:

The vascular pattern of the extensor carpi radialis muscle in the present study appeared belonging to type II, while Purinton et al. (1992) in the same animal recorded that the muscle resembled type I in 90 % of the cases. Also, the vascular pattern of the common digital extensor muscle in our investigation confirmed that found by the latter authors in that it belonged to type II. However, due to the functional significance of these two muscles, it would be suggested that they do not appear useful as free muscle flaps.

M. extensor digitorum lateralis:

The vascular pattern of the lateral digital extensor muscle in the current investigation mostly resembled type IV, while it was reported by Purinton et al. (1992) to be of type I. Meanwhile, the muscle is not recommended to be used as a muscle flap due to its small size and unfavourable vascular pattern. Similar results were obtained in human by Mathes and Nahai (1981) and Chang and Mathes (1982), who mentioned that a muscle flap should be of reasonable size and bulk and with a suitable vascular pattern.

M. extensor carpi ulnaris:

The arterial pattern system of the muscle mostly resembled type II and might be rotated at its proximal portion around the large cranial interosseous pedicle, a result which was confirmed by Purinton et al. (1992) in the same animal.

Legends of figures

Fig. (1A): A photograph of the lateral aspect of the shoulder and arm of the left thoracic limb of a dog

1- M. deltoideus (pars scapularis)

/1 - M. deltoideus (pars acromialis)

2- M. triceps brachii (Caput longa)

/2 - M. triceps brachii (Caput laterale)

3- M. cleidobrachialis (of brachiocephalicus)

4- Olecranon process of ulna

5- M. cutaneous trunci

Fig. (1B): A photograph of the lateral aspect of the shoulder, brachium and thoracic wall of a dog (the cutaneous trunci has been resected)

1- M. trapezius (pars cervicalis).

/1 -M. trapezius (pars thoracis).

2- M. deltoideus (pars scapularis).

/2 -M. deltoideus (pars acromialis).

3- M. triceps brachii (caput longa).

/3 -M. triceps brachii (caput laterale).

4- M. brachialis.

5- M. latissimus dorsi.

6- Olecranon process of ulna.

7- V. cephalica.

8- M. cleidobrachialis.

9- V. axillobrachialis

10- M. extensor carpi radialis.

11- M. omotransversarius.

12- M. infraspinatus.

Fig. (2): A photograph of the lateral aspect of the left thoracic limb of a dog.

1- M. cleidobrachialis.

2- M. triceps brachii (Caput laterale)

3- Olecranon process of the ulna

4- Lateral epicondyle of the humerus

5-M. extensor carpi radialis

6- M. extensor digitorum communis

7- M. extensor digitorum lateralis

8- M. extensor carpi ulnaris

9-M. flexor carpi ulnaris (Caput ulnare)

Fig. (3): A photograph of the medial aspect of the shoulder and brachium of a dog.

1- M. cleidobrachialis.

2- M. supraspinatus.

3- M. serratus ventralis (cut edge).

4- M. subscapularis.

5- M. teres major.

6- M. latissimus dorsi.

7- M. coracobrachialis.

8- M. pectoralis profundus.

9- M. pectoralis superficialis.

10- A. axillaris.

11- A. thoracica externa.

12- Ramus deltoideus (of axillary artery).

13- A. subscapularis.

14- A. thoracodorsalis.

15- A. circumflexa humeri caudalis.

16- A. brachialis.

17- A. profunda brachii.

18- N. radialis (reflected)

19- N. subscapularis.

20- M. biceps brachii.

21- M. triceps brachii (caput mediale).

22- M. triceps brachii (caput longa).

23- M. tensor fascia antebrachii.

Fig. (4): A photograph of the medial aspect of the brachium and antebrachium of the right thoracic limb of a dog

1- M. pectoralis profundus.

2- M. pectoralis superficialis

3- M. biceps brachii.

4- M. triceps brachii (caput mediale).

5- M. triceps brachii (caput longa).

6- M. tensor fascia antebrachii (reflected).

7- Humerus.

8- M. extensor digitorum communis

9- M. extensor carpi radialis (cut).

10- M. flexor carpi radialis.

11- M. flexor digitorum profundus (caput humerale)

12- M. flexor digitorum superficialis.

13- Combined trunk of the median & ulnar nerves

14- N. medianus.

15- N. ulnaris.

16- N. musculocutaneous.

17- A. brachialis.

18- A. bicipitalis.

19- A. transversaria cubitalis.

20- A. mediana.

21- A. radialis.

22- M. flexor carpi ulnaris (caput ulnare).

Fig. (5A): A photograph of the medial aspect of the antebrachium of the thoracic limb of a dog

1- M. extensor carpi radialis (cut & reflected).

2- M. biceps brachii.

3- Tendon of insertion of biceps brachii.

4- N. medianus.

5- A. bicipitalis

6- A. recurrens ulnaris.

7- A. interossea communis.

8- A. ulnaris.

9- A. mediana.

Fig. (5B): A photograph of the medial aspect of the brachium and antebrachium of the right thoracic limb of a dog

1- M. latissimus dorsi.

2- M. flexor carpi radialis (stretched).

3- M. flexor digitorum superficialis.

4- N. radialis.

5- N. medianus.

6- N. ulnaris

7- N. thoracodorsalis.

8- A. profunda brachii.

9- A. transversaria cubitalis.

10- A. interossea communis.

Fig. (6): A medio-lateral radiograph of an arteriogram of the right thoracic limb of a dog

A- A. axillaris

E- A. thoracica externa

L- A. thoracica lateralis

S- A. subscapularis

/S -A. circumflexa humeri caudalis

//S -A. thoracodorsalis

b- A. brachialis

C- A. circumflexa humeri cranialis

D- A. profunda brachii

B- A. bicipitalis

U- A. collateralis ulnaris

T- A. transversaria cubitalis

F- A. brachialis superficialis

N- A. recurrens ulnaris

I- A. interossea communis

M- A. mediana

R- A. radialis.

Fig. (7): A photograph showing the arterial pedicle system for M. deltoideus.

1- Caudal circumflex humeral pedicles.

2- Subscapular pedicles.

3- Suprascapular pedicle.

A- Pars acromialis of the muscle.

S- Pars scapularis of the muscle.

Cr- Cranial border of the muscle.

Ca- Caudal border of the muscle.

Fig. (8): A photograph showing the arterial pedicle system for M. infraspinatus.

1- Subscapular pedicles.

2- Caudal circumflex humeral pedicle.

3- Suprascapular pedicle.

Fig. (9): A photograph showing the arterial pedicle system for M. teres major.

1- Subscapular pedicle.

2- Thoracodorsal pedicle.

Cr- Cranial border of the muscle.

Ca- Caudal border of the muscle.

Fig. (10): A photograph showing the arterial pedicle system for M. teres minor.

1 & 2 - Caudal circumflex humeral pedicles.

Fig. (11): A photograph showing the arterial pedicle system for M. biceps brachii.

1- Cranial circumflex humeral pedicle.

2- Superficial brachial pedicle.

Fig. (12): A photograph showing the arterial pedicle system for M. brachialis.

1- Caudal circumflex humeral pedicle.

2- Collateral radial pedicles.

3- Transverse cubital pedicle.

Fig. (13): A photograph showing the arterial pedicle system for M. triceps brachii.

1- Subscapular pedicle

2- Caudal circumflex humeral pedicle.

3- Deep brachial pedicle.

4-Collateral ulnar pedicle.

5- Ulnar pedicle.

6- Cranial interosseous pedicle.

O- Long head of the triceps brachii.

M- Medial head of the triceps brachii.

L- Lateral head of the triceps brachii.

Fig. (14): A photograph showing the arterial pedicle system for M. tensor fascia antebrachii.

1- Thoracodorsal pedicle.

2- Collateral ulnar pedicle.

Fig. (15): A photograph showing the arterial pedicle system for M. flexor carpi radialis.

1- Recurrent ulnar pedicle.

2- Deep antebrachial pedicle.

3- Radial pedicle.

Fig. (16): A photograph showing the arterial pedicle system for M. flexor digitorum superficialis.

1- Recurrent ulnar pedicle.

2- Deep antebrachial pedicle.

3- Caudal interosseous pedicle.

Fig. (17): A photograph showing the arterial pedicle system for M. flexor carpi ulnaris (Caput ulnare).

1- Collateral ulnar pedicle.

2- Ulnar pedicle.

Fig. (18): A photograph showing the arterial pedicle system for M. flexor carpi ulnaris (Caput humerale).

1- Recurrent ulnar pedicle.

2- Deep antebrachial pedicles.

3- Ulnar pedicles.

Cr- Cranial border of the muscle.

Ca- Caudal border of the muscle.

Fig. (19): A photograph showing the arterial pedicle system for M. extensor carpi radialis.

1- Transverse cubital pedicles.

2- Collateral radial pedicle.

3- Caudal interosseous pedicle.

Fig. (20): A photograph showing the arterial pedicle system for M. extensor digitorum communis.

1- Cranial interosseous pedicle.

2- Transverse cubital pedicle.

Fig. (21): A photograph showing the arterial pedicle system for M. extensor digitorum lateralis.

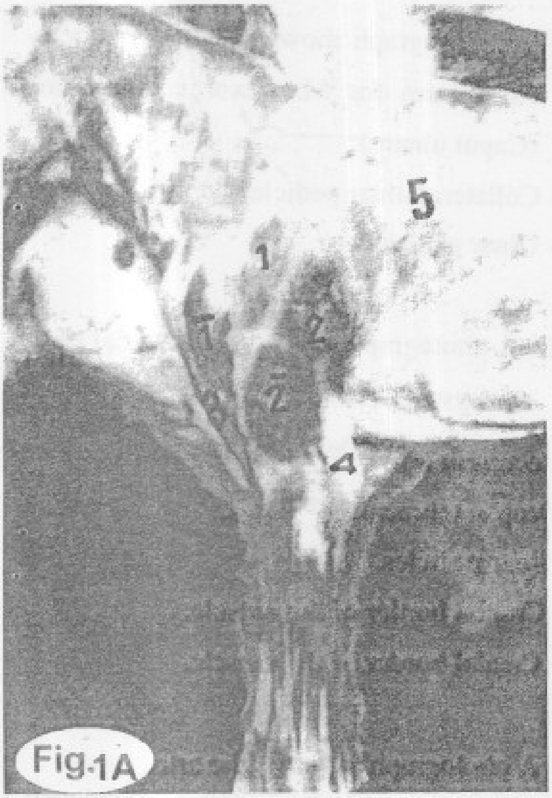
1- Cranial interosseous pedicles.

2- Caudal interosseous pedicles.

Fig. (22): A photograph showing the arterial pedicle system for M. extensor carpi ulnaris.

1- Cranial interosseous pedicle.

2- Caudal interosseous pedicle.



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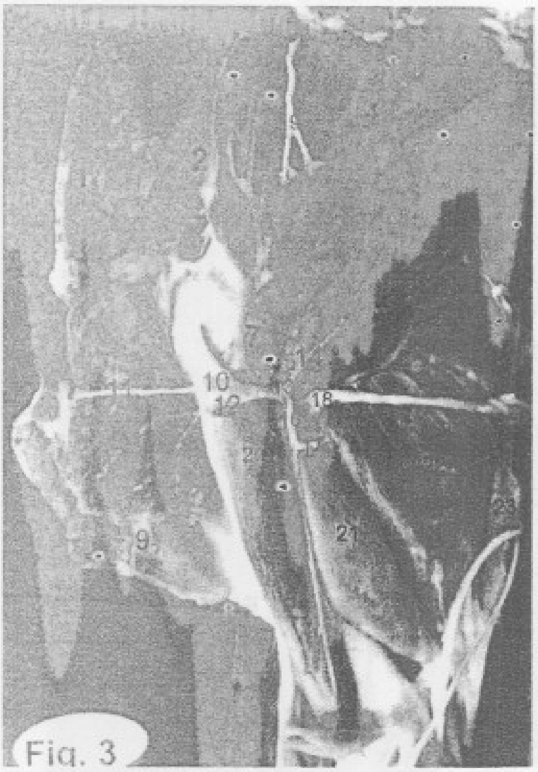

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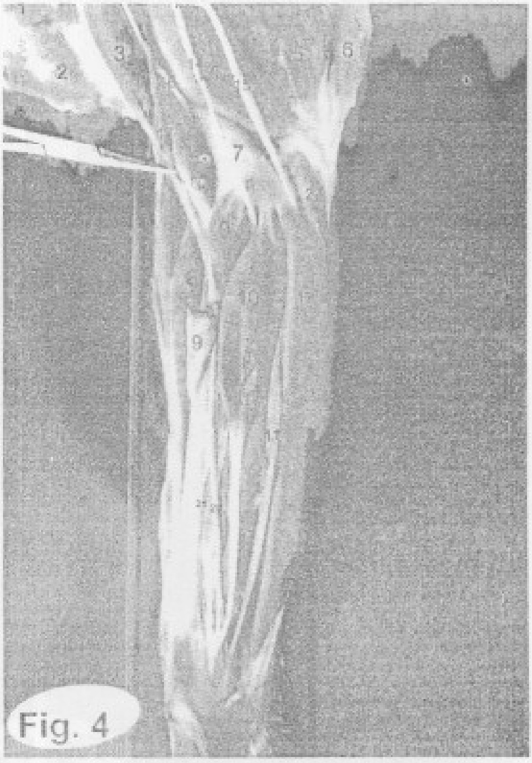

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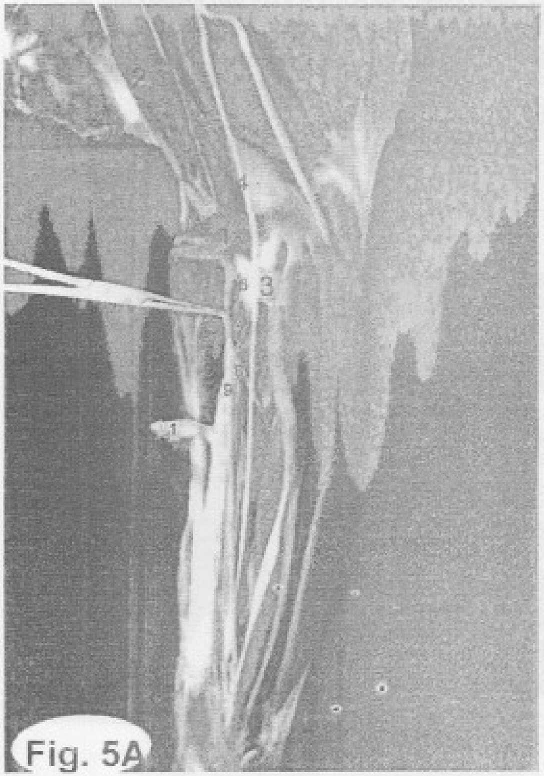

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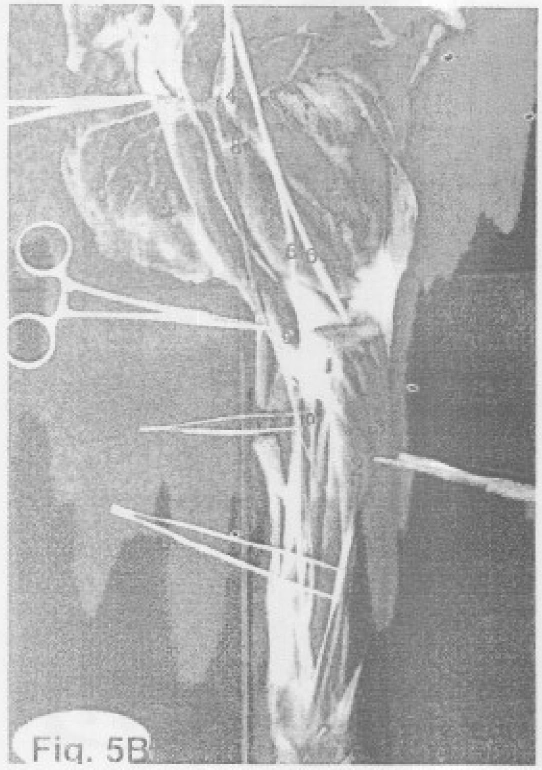

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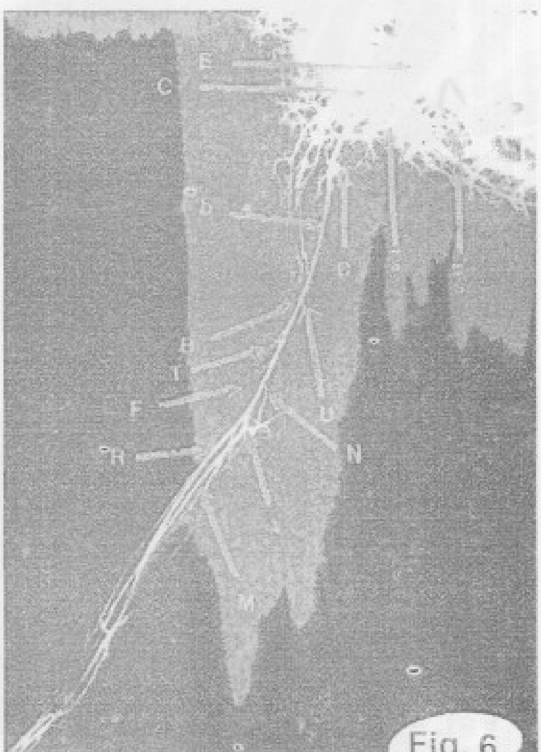

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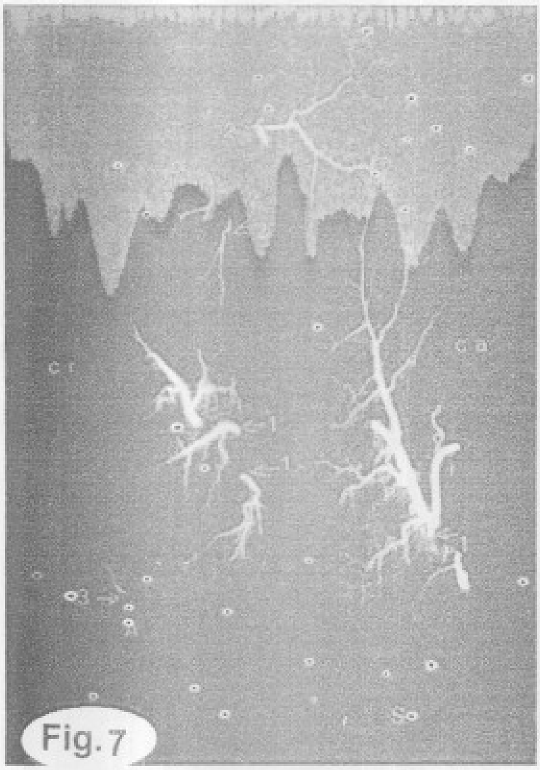

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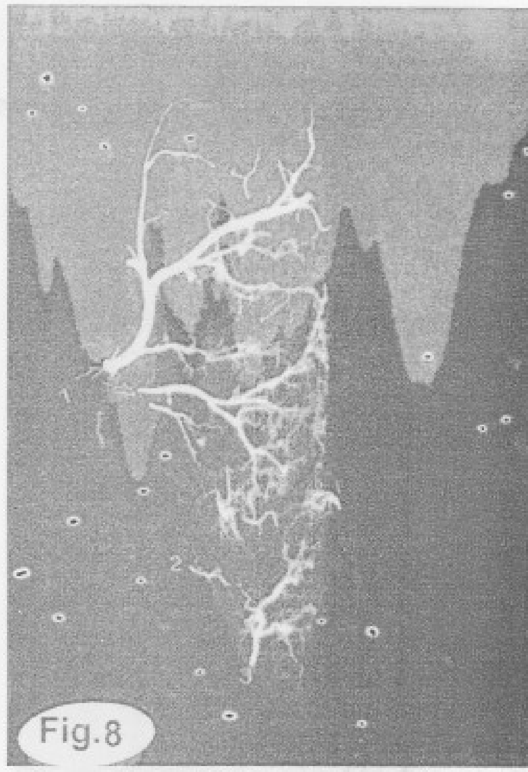

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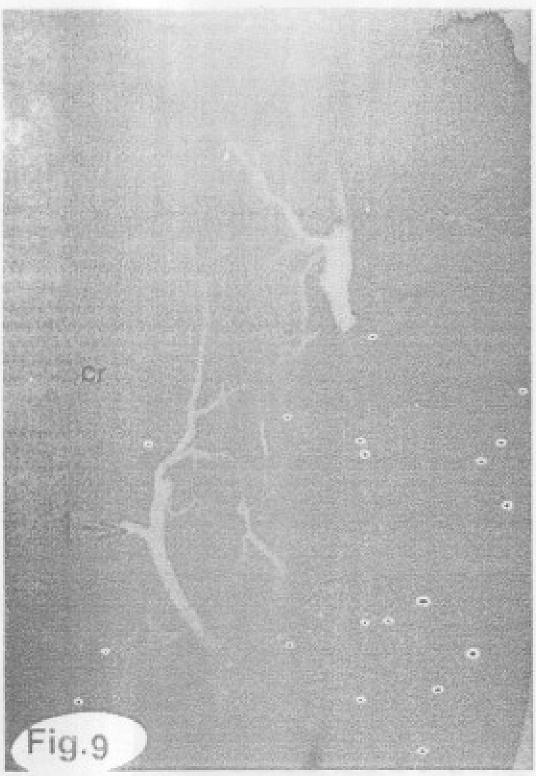

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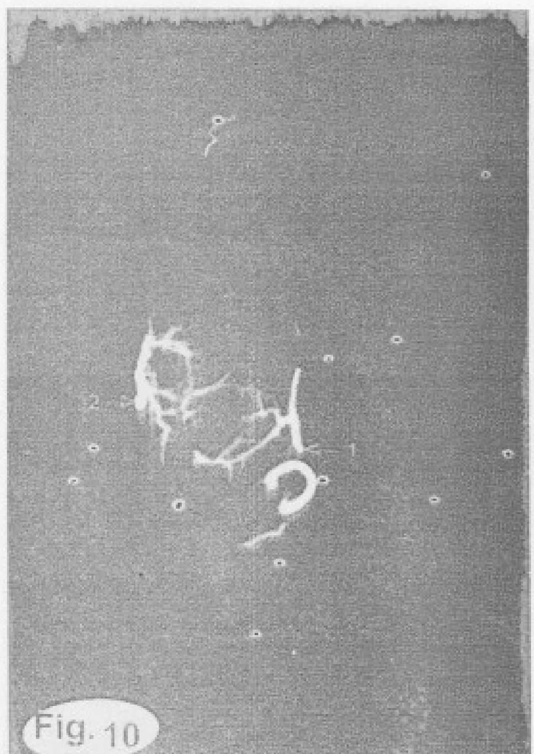

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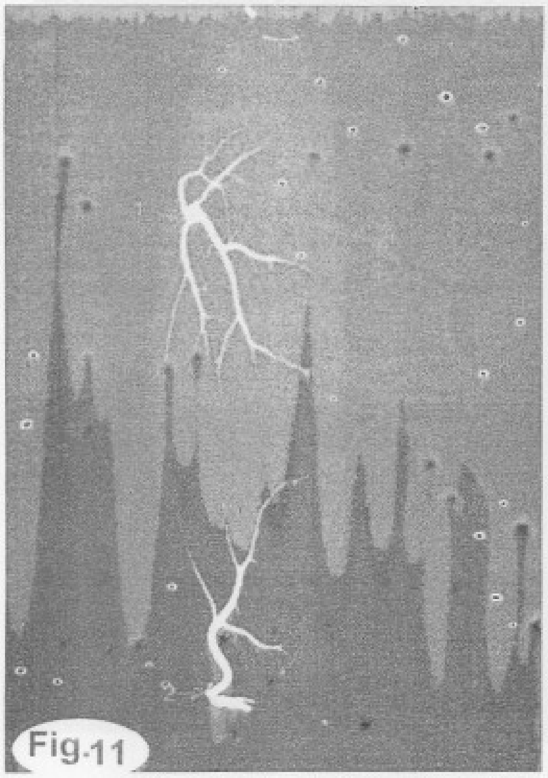
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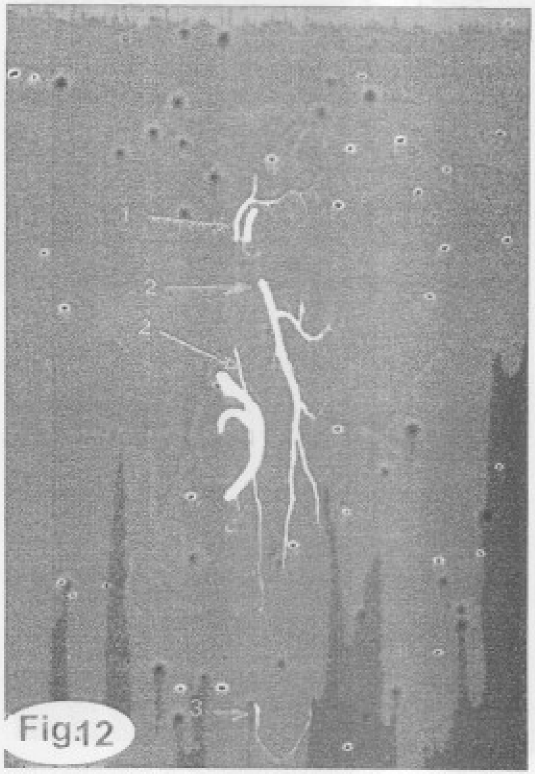
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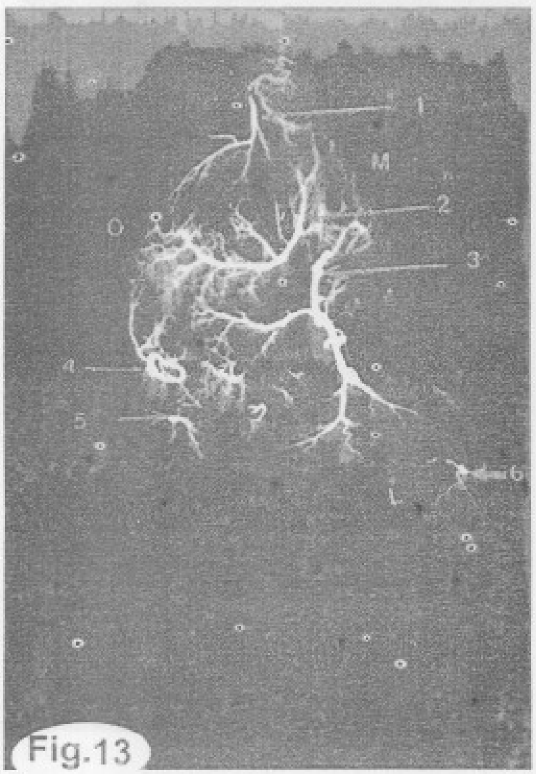
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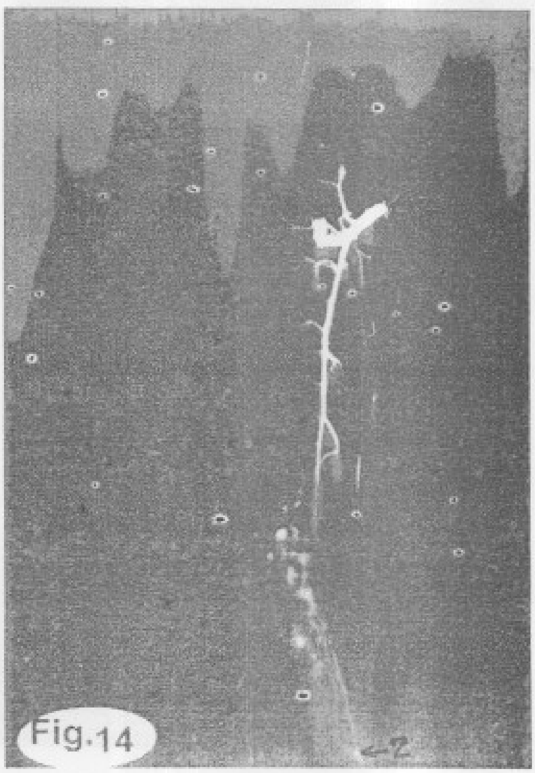
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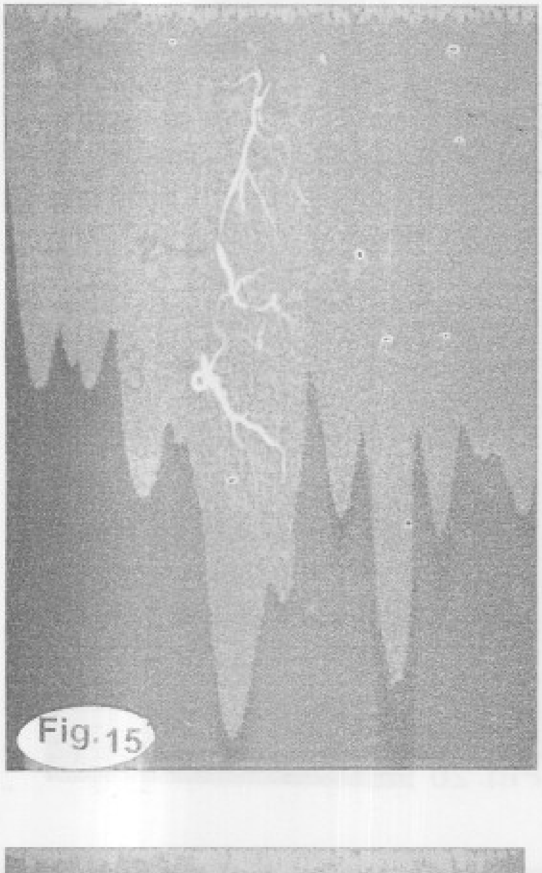
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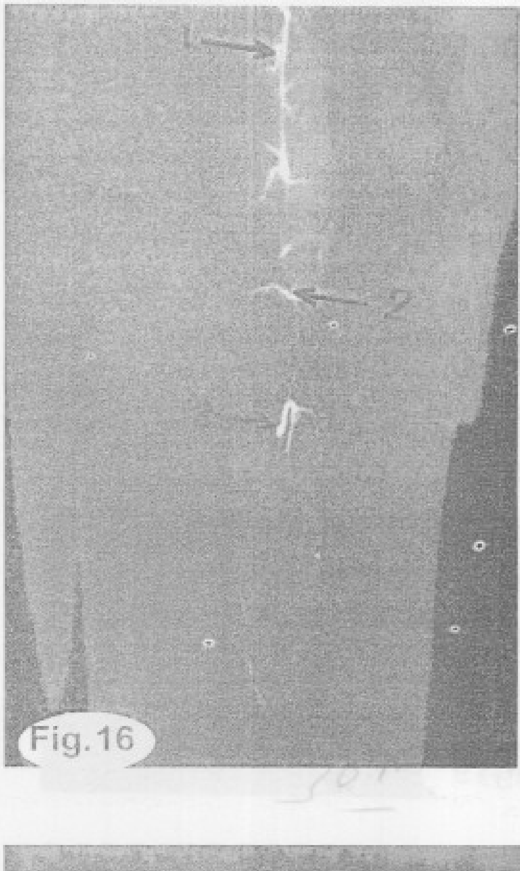
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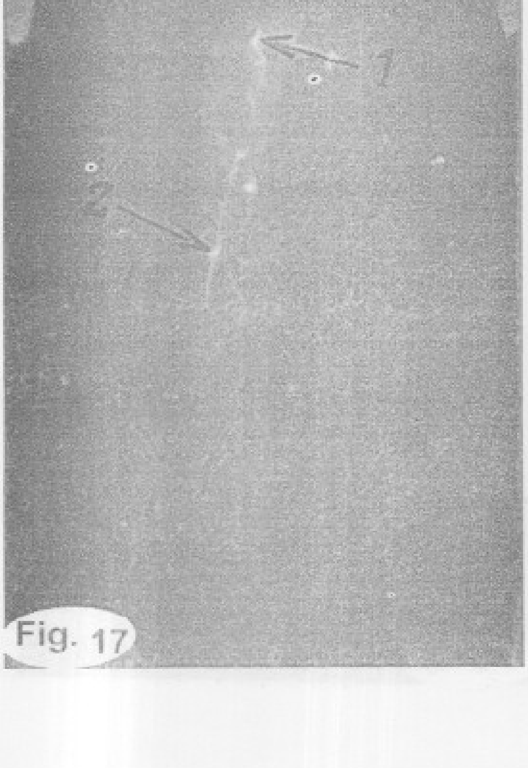
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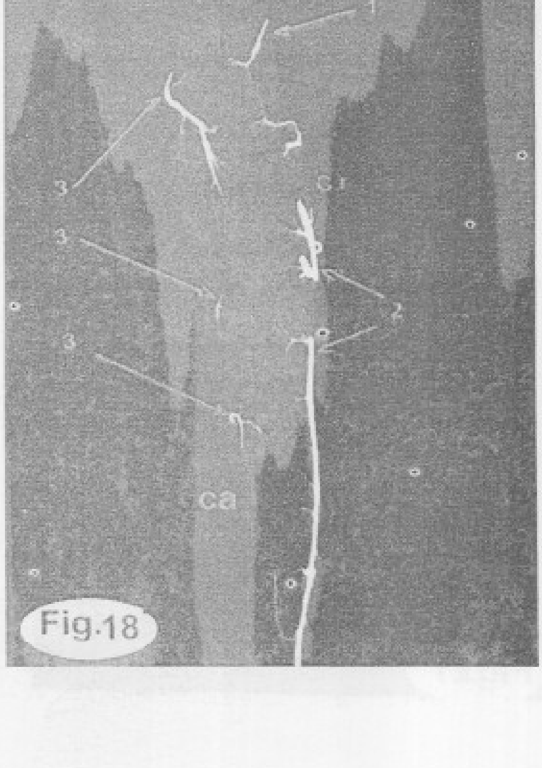
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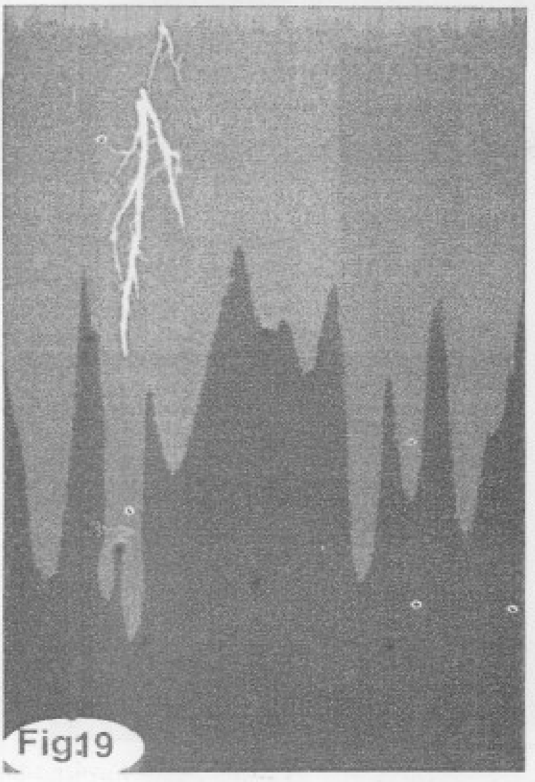
Fig.18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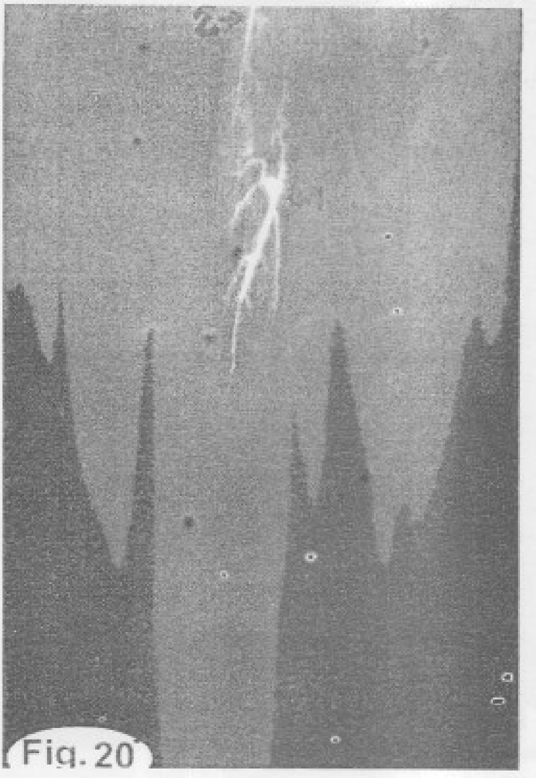
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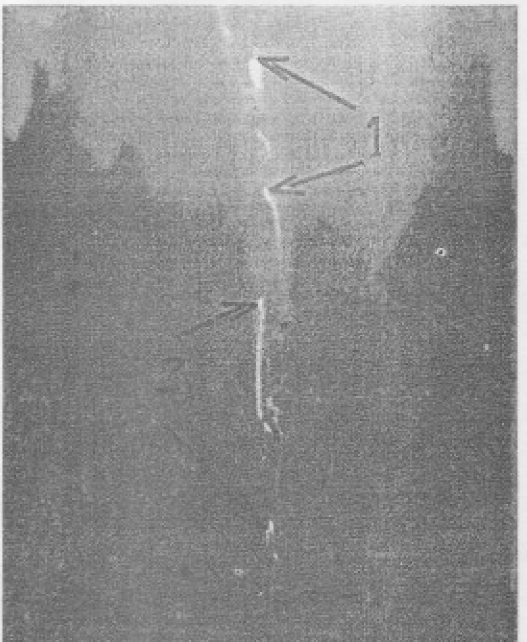

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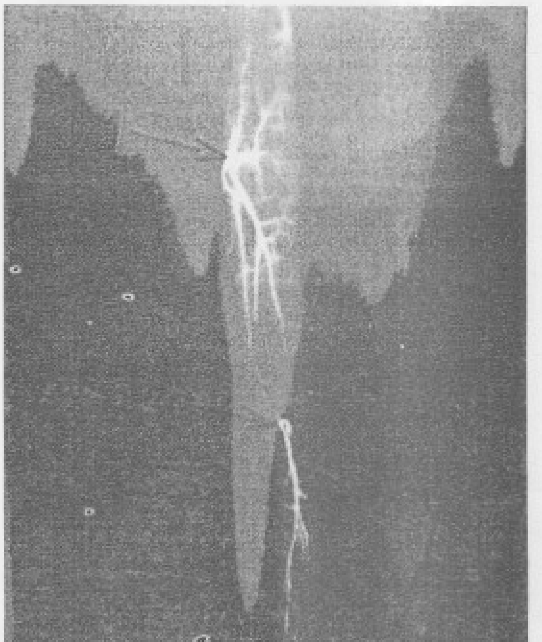
Fig. 22

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