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"MUSCULOCUTANEOUS NERVE AND ITS VARIATIONS"

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ABSTRACT

The precise knowledge of the course, branching pattern and erstwhile variations of the musculocutaneous nerve and its possible communication with the median nerve is valuable in traumatology of the shoulder joint, explorating procedures, flap dissections, etc.,. The intrafascicular distance of each branch of the musculocutaneous nerve is important in microsurgical procedures to develop or refine a surgical methods required, so as to plan adequate treatment and to avoid iatrogenic injuries to the nerve in the neurosurgical department thereby increasing the clear perfection of surgical operative and practical approach. The present study aims to find out the origin, course, branching pattern of musculocutaneous nerve and connections of musculocutaneous nerve in the arm. The present study presented with dissection method. Total 40 upper limbs was procured from embalmed cadavers of J.J.M. Medical College, Davanagere during 2011-12.the detailed study history was obtained from the hospital records. Collected data was analyzed by using Minitab -6.50 version University analyses was employed to draw the significant inference. Matched frequency was used to find out the variations between different categorical and clinical variables. Total 87.5% cases musculocutaneous nerve was arising from the lateral cord, 12.5% cases musculocutaneous nerve was absent and the median nerve was showed different branches to the coracobrachialis, biceps brachii and brachialis. 7.5% cases were musculocutaneous; piercing coracobrachialis muscle and 92.5% cases was seen piercing the coracobrachialis muscle. The mean point of the nerve piercing coracobrachialis emergence was 6.55 cms. 87.5% cases expressed the branch to coracobrachialis and it was from musculocutaneous nerve, 2.5% from lateral cord and 10% variation from median nerve with mean point of origin of nerve to short head and long head of biceps were 11.54 cm and 15.44cms respectively. The mean point of the origin nerve to brachialis was 16.41cm.Communication between musculocutaneous nerve and median nerve was noted in 17.5% cases. The present study, quantified that intercommunication between musculocutaneous nerve and median nerve is 17.5%. The number of branches to biceps brachii as varied between 1-2 cms and the number of branches to brachialis is varied between1-3cms.

KEYWORDS: Musculocutaneous Nerve, Coracobrachialis, Median Nerve

INTRODUCTION

The musculocutaneous nerve is the nerve of the anterior compartment of the arm and arises from the lateral cord of the brachial plexus opposite the lower border of the pectoralis minor muscle. Fibres are derived from fifth, sixth and seventh cervical nerves and mixed with peripheral nerve. Passes through the coracobrachialis muscle, emerges to pass between the biceps brachii and brachialis, supplying these three muscles. It continues as the lateral cutaneous nerve of the forearm at the lateral margin of the biceps brachii.

Rarely this kind of nerve may be affected by compression due to hypertrophy or entrapment between the biceps aponeurosis and brachialis fascia. The nerve has been showed frequent variations in its origin, composition of fibre bundle, course and branching pattern. The presence of anatomic variations of the peripheral nervous system often forms the basis of unexpected clinical signs and symptoms. Descriptions and pattern of nerve variations are useful in clinical and surgical practice, since an anatomical variation can be the cause of a nerve palsy syndrome due to a different relation of a

nerve and a related muscle. In most of these cases, surgery can lead to a rapid recovery of nerve function. Hence the surgeon should be familiar with the neurovascular variations not to cause any iatrogenic damage to these structures during their retraction for exposure of fracture limit. Variant anatomy recognized during routine cadaveric dissection. Learning potential provides a framework to review the embryogenesis of the structure in question and an insight into its surgical, medical and radiological implications. And imparts the concept of patient uniqueness and subsequent individualization of medical and surgical therapies. Usually anterior approach for internal fixation of humeral fracture is considered safer than the posterior approach due to risk of radial nerve injury in the latter. In such cases awareness of the neurovascular variations in the arm, especially obliquely coursing communicating branches between the nerves is essential to prevent any damage to these structures. Normal and anomalous position of the arteries and veins may be determined preoperatively by angiographic studies, but in case of nerves it is not possible to detect such an anomaly. Only at the time of surgery the surgeon is exposed to such variations. Prior knowledge of the possible variations is essential as the eye cannot see what the mind does not know. Coracoid graft transfers are done in Bristow and Lalerjet procedures in repair of recurrent dislocation of shoulder. In transfer of the coracoid process to the anterior glenoid, an attempt is made to create an anteroinferior musculocutaneous sling. The rates of complications are higher than for soft tissue reconstructions as the subscapular nerve, musculocutaneous nerve and axillary nerve can be injured. The coracobrachialis is used as a transposition flap in deformities of infraclavicular and axillary areas and in post mastectomy reconstruction. During this procedure, structures piercing the coracobrachialis muscle are liable to get injured, especially if there is an unnoticed variation.

The musculocutaneous nerve, being in close proximity to the shoulder and arm, is frequently involved in injuries and surgical procedures in this region, especially if there is an unexpected variation. Good knowledge of the course, branching pattern and variations of the musulocutaneous nerve and its possible communications with the median nerve is valuable in traumatology of the shoulder joint, explorating procedures, flap dissections, post traumatic evaluation of the arm or peripheral nerve stimulation in practice of anesthesia and has gained more importance due to the wide use and reliance on computer image processing. The intrafascicular distance of each branch of the musculocutaneous nerve is important in microsurgical procedures and to develop or refine surgical procedures required. So as to plan adequate treatment and to avoid iatrogenic injuries to the nerve in the Neurosurgical department there by increasing the perfection of surgical approach. Hence the present studies find out the origin, course, and branching pattern of musculocutaneous nerve and correlated with connections of musculocutaneous nerve in the arm.

METHODOLOGY

The present study was done on 40 upper limbs from embalmed cadaver's dissection in the Department of Anatomy, J.J.M. Medical College, and Davanagere.sub samples comprises 32 male and 8 female upper limbs. Dissection was done based on guidelines of Cunningham's manual. Pectoralis major was cut at its origin and reflected towards its insertion. Contents of the axilla were exposed, removing the loose connective tissue, fat and lymph nodes. The coracobrachialis and short head of biceps were identified and cleaned. Branch of the musculocutaneous nerve to the coracobrachialis was identified with standard procedure. Deep fascia of the anterior surface of the arm was divided upto elbow, and the biceps brachii was uncovered and cleaned. Musculocutaneous nerve running is between biceps and brachialis was identified and the branches to these muscles were documented. The emergence of the nerve from beneath the lateral border of the tendon of biceps as the lateral cutaneous nerve is the forearm was recorded. Any variation like origin or branching pattern of the musculocutaneous nerve was carefully noted. Inter communication between the musculocutaneous nerve and the median nerve was recorded. Measurements were taken keeping the limb at 90°, and the forearm facing upwards with level level of origin of the musculocutaneous nerve, entry and exit from coracobrachialis

muscle, branches to the muscles, pierces the deep fascia, lateral border of the biceps brachii. Communication between the musculocutaneous nerve and the median nerve. The dissected specimens were numbered, the photographs observation were noted. Descriptive statistical methods (percentage, mean and standard deviation) were used to analyse the study. Collected data was analyzed by using Minitab -6.50 version .University analyses was employed to draw the significant inference. Matched frequency was used to find out the variations between different categorical and clinical variables.

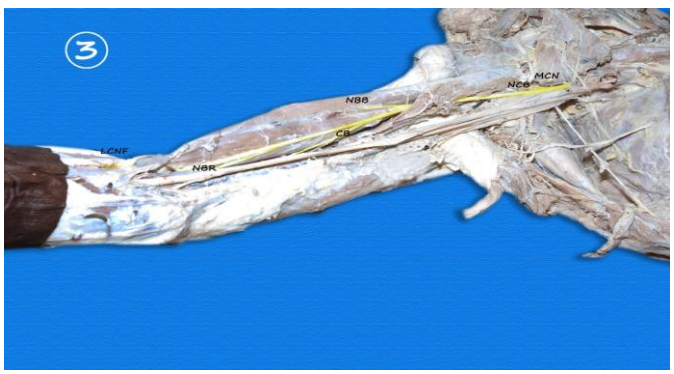
Table 1

Observation		Specimens			
	01Side:Right		02Side: Right	03 Side: Right	04Side: Right
Branches		**Level of Origin from Tip of CP in cm**			
Coracobrachialis		4	3	4.5	3
Biceps brachii	Long head	15	11	11.2	10.5
	Short head	12	11	11.2	10
Brachialis		17	19	14.5	17
Lateral cutaneous nerve of forearm		28.5	28	23	28
Level of origin of MCN		3 cm	3 cm	3.5 cm	3 cm
Level of entry into CB		6 cm	6 cm	7.5 cm	Not piercing coracobrachialis
Level of exit from CB		10cm	10cm	8.5 cm	-
Variation		Nil	Yes	Yes	Nil

*Specimen No:01 Variation Nil*Specimen No:02 Variations : Communicating branch to median nerve at 15 cm from corocoid process Specimen:03 Communicating branch to median nerve at 14 cm from co racoids process, Specimen No 04 Variation: Nil

Specimen: 1

Specimen: 2



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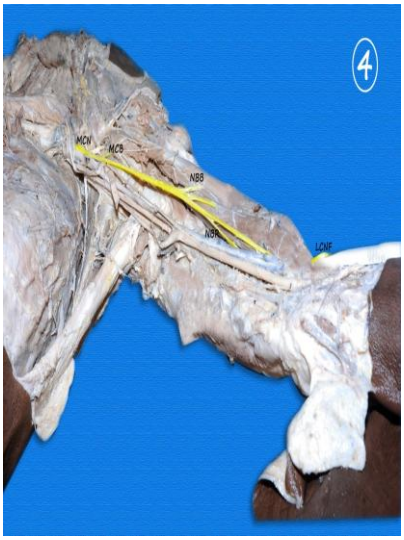
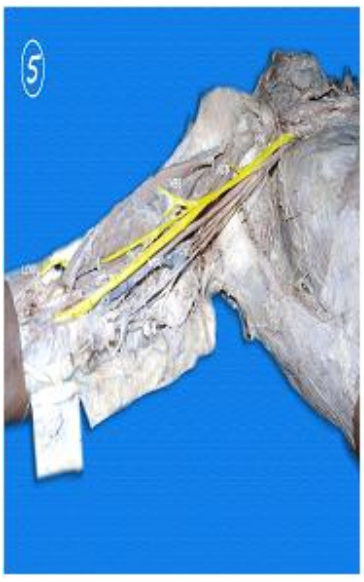


Specimen: 4

Table 2

Observation	Specimens				
	05Side:Right		06Side: Right	07 Side: Right	08Side: Right
Branches		Level of Origin from Tip of CP in cm			
Coracobrachialis		04	3	4	4
Biceps brachii	Long head	-	12.5	14.5	14.5
	Short head	-	10.5	14.5	14.5
Brachialis		-	15.5	15	15
Lateral cutaneous nerve of forearm		-	29	25	25
Level of origin of MCN		-	2 cm	3 cm	3.5 cm
Level of entry into CB		-	5.5 cm	5 cm	6 cm
Level of exit from CB		-	9 cm	9.5 cm	11.5 cm
Variation		Yes	Nil		Yes

*__Note:__ Variation 05: Absence of musculocutaneous nerve branches arises from median nerve to short and long head of biceps brachii and brachialis.Lateral cutaneous nerve of forearm arises from the same trunk. Variation 06: Communicating branch to median nerve at 14 cm from coracoids process, Variation07: Communicating branch to median nerve at 14 cm from coracoids process.Vriation: 08Communicating branch to median nerve at 13 cm branch to short & long head of biceps brachii arise from common trunk



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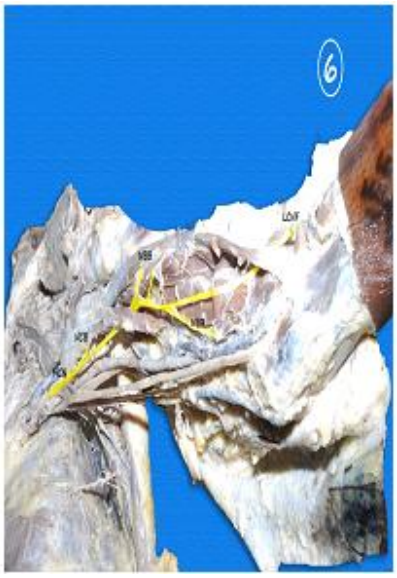

Specimen: 6

Specimen: 7 **Specimen: 8**

Table 3: Descriptive Statistics of Branches of Musculocutaneous Nerve

	Mean	SD	Median
Level of origin of MCN	3.33	0.92	3.00
Branch to CB	4.30	1.10	4.25
Entry into CB	6.55	1.99	6.00
Exit from CB	9.27	1.90	9.00
Branch to short head	11.54	1.47	12.00
Branch to long head of BB	15.44	17.00	13.00
Branch to brachialis	16.41	2.06	16.00
Lateral cutaneous nerve of forearm	26.73	2.49	27.00

RESULTS

Present study total 40 upper limbs (20 rights and 20 left) from the embalmed cadavers were used to find out musculocutaneous nerve and its variations. Observations were made as per the parameters and objective of the study. Out of 40 specimens, 35 specimens (87.5%) were expressed musculocutaneous nerve arised from the lateral cord of brachial plexus. In five cases the musculocutaneous nerve was absent, and the branches to the muscles of arm were arised from the median nerve. Three (7.5%) cases was musculocutaneous nerve and it was not piercing the coracobrachialis muscle; 37 (92.5%) cases were piercing the coracobrachialis muscle. Mean value obtained from the point of penetration was 6.55 with average ratio was 6.3 cm.Most proximal and distal points of entry of the nerve was 3.5 and 11 cm respectively. And also with distal points of exit of the nerve was 4.5cm and 12.5cm respectively; Mean value obtained from point of emergence was 9.27 with average ratio was 9.87cm.

Branches of Musculocutaneous Nerve -Nerve to Coracobrachialis

The nerve to coracobrachialis arose from musculocutaneous nerve and entered the muscle just above the point of penetration of coracobrachialis by the musculocutaneous nerve trunk (87.5%). Only one case (2.5%) arose from lateral cord and 4 (10%) arose from the median nerve.

Nerve to Biceps Brachii: The nerve to biceps brachii originated from musculocutaneous nerve was 87.5% and 12.5% was arised from the median nerve.

Level of Origin: The mean point of origin of nerve to short head of biceps brachii and nerve to long head of biceps brachii was 11.54 cm with ratio 10.6: 15.44, with average ratio was 12.4.2 .Ten percent of the nerves to short and long heads of

biceps were arising from a common trunk. 32% case were expressed the nerves to short and long heads arose at the same level.

Nerve to Brachialis: 87.5% cases expressed that, the nerve to brachialis arose from musculocutaneous nerve and only 5 cases were arose from median nerve. The most proximal and distal points of origin of nerve to brachialis were 11.5 and 20 respectively.

Lateral Cutaneous Nerve of Forearm: 35 arms lateral cutaneous nerve of forearm arose from musculocutaneous nerve and 5 arms were arisen from median nerve with mean value was 26.73.

Communication between Musculocutaneous Nerve and Median Nerve

Communication between musculocutaneous nerve and median nerve was noted and it was expressed (17.5%).

DISCUSSIONS

The musculocutaneous nerve (C4–C6), a mixed peripheral nerve, arising from the lateral cord of the brachial plexus in the axilla, usually innervates the muscles of the anterior compartment of the arm and then continues as the lateral cutaneous nerve of the forearm [9]. Prasada Rao [6] reported two cases of absent musculocutaneous nerve from the lateral cord of the brachial plexus. In the present study, the absence of the musculocutaneous nerve was observed in 3 specimens. Ihunwo et al [8] reported a case of the bilateral absence of the musculocutaneous nerve from the lateral cord of the brachial plexus, with four branches arising from the lateral side of the median nerve. This report was in discrepancy with that of the present study, where there was only the unilateral absence of the musculocutaneous nerve in 3 cases.

Nakatani et al [47] and Le Minor [48] observed the absence of the musculocutaneous nerve from the lateral cord of the brachial plexus and the branches from the lateral cord directly supplied the anterior compartment muscles of the upper arm. They also observed the formation of the median nerve by the union of the lateral root with the medial root in the upper arm and the lateral root was in fact, a continuation of the lateral cord after giving off the muscular branches. In the cases which are reported here, there was also the absence of the musculocutaneous nerve in 3 limbs, but the median nerve was formed in the axilla and not in the upper arm and in one case ,the lateral root of the median nerve was a direct continuation of the lateral cord. In two cases ,after giving off the lateral root of the median nerve,the lateral cord continued to run for a short distance in the axilla and joined the median nerve. Nakatani et al [10] and Le Minor [11

The musculocutaneous nerve was dissected in 40 upper limbs and the findings were recorded. Present study of 40 upper limbs, musculocutaneous nerve arose from lateral cord in 35 specimens (87.5%). It was absent in 5 limbs (12.5%). many authors observed that two cases (18.33%) expressed absence of musculocutaneous nerve in 24 upper limbs. Median nerve took over the area of supply of the musculocutaneous nerve by giving muscular and sensory branches.[9, 30, 22]. Present study documented that, the entire lateral cord was combined with the median nerve by the formation of a common nerve trunk. As the nerves are named according to the course they pass through or their innervations and not depending on their origin, it was reasonable to assume that the combined nerve was the median nerve and musculocutaneous nerve did not actually exist.

Brachial plexus appeared as a single cone which divided into ventral and dorsal roots to median nerve and ulnar nerve. Musculocutaneous nerve arose from the median nerve. This primitive embryological origin of the musculocutaneous nerve from the median nerve was retained in two cases [9]

Our study noticed that, the musculocutaneous nerve descended down to pierce coracobrachialis and it was expressed 92.5%. The distance from tip of coracoids process to the point of entry into coracobrachialis varied from 3.5 to

11 cm (average 7.25 cm). Musculocutaneous nerve into coracobrachialis is variable which ranges from 1.5 to 9.5 cm[9]. Limbs 03(7.5%) of the musculocutaneous nerve passed between biceps brachii and brachialis muscle without piercing coracobrachilais. Rao et al, have described that 9.3% musculocutaneous nerves did not pierce coracobrachialis muscle.

The musculocutaneous nerve ordinarily enters coracobrachialis muscle from its medial aspect approximately 5 cm distal to tip of coracoids process. It may run behind the coracobrachialis muscle or may be accompanied by fibres from the median nerve as it transmits coracobrachialis. Less frequently the reverse occur.[24] Six out of fifty four dissections where the musculocutaneous nerve was present the nerve did not pierce the coracobrachialis[26]

The nerve not piercing the muscle can be explained on embryological basis. The forelimb muscles develop from the mesenchyme of the paraxial mesoderm during the 5th week of embryonic life. The axons of spinal nerves grow distally to reach the limb bud mesenchyme. There are multiple possibilities for the route taken and the guidance of the developing axons is regulated by expression of chemoattractants and chemorepulsants in a highly corrdinated site specific fashion. Any alteration in signaling between the mesenchymal cells and neuronal growth cones can lead to significant variations. Such developmental anomalies for axonal guidance in the coracobrachialis can lead to a situation where the musculocutaneous nerve does not pierce the coracobrachialis.[26]

Nerve to Coracobrachialis: At least one of the nerves to coracobrachialis arose from the lateral cord in 32.1% cases.[27]

Present study documented, the nerve to coracobrachialis muscle arose from the musculocutaneous nerve was (87.5%), two limbs (5%) arose from the lateral cord, 3 limbs (7.5%) arose from lateral root of median nerve. The average point of origin of the nerve to coracobrachialis from the tip of the coracoids process was 3.775 cm.

The Number of Branches to Coracobrachialis Muscle: In previous study, the number of branches given to coracobrachialis was one in 55.45%, 2 in 31.19%, 3 in 10.09% and 4 in 2.57%. Present study, the number of branches to coracobrachialis given from all sources was one in all the specimens (100%).

Nerve to Biceps Brachii: The nerve to biceps brachii usually arose from the musculocutaneous nerve after the musculocutaneous nerve had emerged from the coracobrachialis muscle in cases where it originated from the lateral cord.[13]

Nerve to biceps brachii arose from musculocutaneous nerve in 35 cases (87.5%).Only five cases; the branch to biceps brachii arose from the median nerve (12.5%) with average point of origin of the branch to biceps brachii was 122±12mm from the tip of coracoids process.[12]

In one case the nerve to biceps brachii was seen to arise from the musculocutaneous nerve within the coracobrachialis muscle.[16] Present study we noticed that ,the point of origin of nerve to short head and long head biceps brachii varies between 7 – 13.5 cm with average is 11.54 and 15.44 respectively.

Number of Branches to Biceps Brachii

Usually one primary branch to biceps brachii arose from the musculocutaneous nerve and later it split into 2 secondary branches to supply each head of the muscle.

The branches to biceps brachii were classified

- **Type I →** One primary branch arose from the musculocutaneous nerve which later bifurcated into 2 to supply each head of the muscle separately (62%).
- **Type II →** Two primary branches, to each head of the biceps brachii were seen. The proximal branch always supplied the short head (33%).

Type III → Three primary branches to the biceps brachii were seen (5%). In most of these cases (4/6), the 3rd branch supplied the third head of biceps brachii. Remaining (2/6), the 3rd branch supplied the distal part of biceps brachii at its common belly.16

Present study, we documented the number of branches to biceps brachii and it was arose directly from the musculocutaneous nerve was 35 (87.5%), out of which 15 limbs showed that both short and long head were supplied by a branch which later bifurcated into 2 to supply each head of muscle separately (42.8%).2 branches supplied biceps brachii in 18 cases, out of which 16 cases expressed one branch (proximal) directly supplied short head of biceps whereas the other branch supplied the long head (5.71%).

5.71% variation observed in two primary branches from musculocutaneous nerve .The proximal branch bifurcated in to 2 to supply the 2 heads of the muscle. The 2nd branch innervated the distal part of biceps at its common belly. 12.5% the branch to biceps brachii arose from the median nerve.

Nerve to Brachialis: The nerve to brachialis usually arose from the musculocutaneous nerve distal to the branch to biceps brachii. Cases where it arose from the lateral cord had been reported.[29] In the cases where the musculocutaneous nerve was absent, it arose from the median nerve.[8,20,6,10] .Two cases the brachialis muscle also received fibers from the median nerve.[16]present study, 35 cases (87.5%) showed branch arising from the musculocutaneous nerve with average point of origin was 15.175 cm.

Communication between Musculocutaneous Nerve and Median Nerve

Variations involving communication between the musculocutaneous and median nerves are the commonest. The most frequent of these was the presence of a communicating branch that bifurcated from the musculocutaneous nerve and ran distally to join the median nerve. Anastomosis between musculocutaneous nerve and median nerve is by far the most common and frequent of the variations that are observed among the branches of brachial plexus. Communication between the musculocutaneous nerve and median nerve was considered as a recurrent from the phylogenic or comparative anatomical view point.

7(17.5%) cases showed intercommunications between musculocutaneous nerve and the median nerve. The communications were not bilateral in any cadaver. Left the musculocutaneous nerve 0.95 ± 0.42 cm from the formation of this nerve. Point of enhancing the median nerve was 10.25 cm ± 2.32 cm from the formation of median nerve with mean length of this inter connection was 5.50 ± 2.50 cm.

The inter communications between musculocutaneous nerve and median nerve may provide motor and sensory innervations during a defect in these nerves after a trauma. In case of communication between musculocutaneous nerve and median nerve, some fibres of median nerve usually run in the musculocutaneous nerve leaving it to join the proper trunk later. In such cases, a combined lesion of musculocutaneous nerve and part of median nerve would occur in injury to the musculocutaneous nerve. Lesions of the connecting nerve may impose difficulty in diagnosis. Injury to the musculocutaneous nerve, proximal to the anastomotic branch between musculocutaneous nerve and median nerve may lead to unexpected presentation of weakness of forearm muscles. Knowledge of various communications between the musculocutaneous nerve and median nerve may prove valuable in traumatology of the shoulder joint as well as in repair operations.[26]

Present study, an accessory muscle was present which was extending from the deltoid tuburosity to the middle of the forearm. The musculocutaneous nerve was giving branch to this muscle also.

Termination

The lateral cutaneous nerve of forearm pierced the deep fascia lateral to the tendon of biceps brachii with mean distance from the tip of coracoid process was 26.73 cm.

12.5% cases showed the lateral cutaneous nerve of the forearm arising from the median nerve.

CONCLUSIONS

The observation shows that the musculocutaneous nerve has significant variations and these variations have clinical significance in post traumatic evaluations and in the exploratory innervations of the arm for peripheral nerve repair. Most of the variations are the intercommunication between musculocutaneous nerve and median nerve.

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