

Variations in Commencement of Median Nerve

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ABSTRACT

Background: The median nerve, normally formed by two roots from the medial and lateral cords in relation to the axillary artery, but variations in its roots and unusual communications with other nerves are common. These anatomical differences can compromise anesthesia and are vulnerable to iatrogenic injury during surgical procedures of the upper limb. This study was conducted to determine the prevalence of such anatomical variations in axillary and arm regions.

Methods: A descriptive cross sectional study was conducted on 66 upper limbs from embalmed adult human cadavers, selected using a convenience sampling method. The median nerve was observed after dissections in the axillary and arm regions for variations in formations and nerve communications. Variations were photographed, and the data were recorded and analyzed using SPSS™ version 20.

Results: The median nerve was most commonly formed in the axilla (78.78%), with one case showing a high formation at the apex. A third root was present in 7.58% of cases, and one rare case involved four roots. Communication with the musculocutaneous nerve occurred in 13.63% of limbs, including a case with two separate communicating roots. Communication with the ulnar nerve was observed in 3.03% of cases.

Conclusions: Anomalous origin, aberrant branching patterns, and unusual communications of the median nerve are possible and clinically significant. Awareness of such variations is essential for accurate diagnosis, effective anesthesia, and safe surgical interventions involving the upper limb.

Keywords: Brachial plexus; cadaveric study; communication; dissection; median nerve.

INTRODUCTION

The median nerve is one of the terminal branches of the brachial plexus, usually formed in the axilla by union of medial and lateral roots arising from the medial and lateral cords, respectively. If the lateral root is small, it may be connected to the musculocutaneous nerve. The nerve usually does not give off branches to the muscles of the arm.¹

The median nerve shows frequent variations at its commencement; number of roots, distribution, relation to adjacent structures and communications with other nerves. It may also exhibit bilateral dissimilarity.²⁻⁴ There have been no prior reports documenting a contribution from the middle trunk to the roots of the median nerve.

Understanding the anatomical variations of the median nerve and its communications with other branches of brachial plexus is crucial for interpreting nerve

dysfunctions, effective anesthetic blocks in the upper limb, managing entrapment syndromes, and preventing postoperative neural complications. Therefore, the present study was conducted to explore the possible variations in the formation and early course of the median nerve.

METHODS

This was a descriptive cross-sectional study conducted from January 2023 to December 2024, after obtaining ethical clearance from the Institutional Review Committee of the Nepalese Army Institute of Health Sciences (NAIHS-IRC, Reg. No. 676). Data were collected in the dissection hall of the Department of Anatomy, Nepalese Army Institute of Health Sciences, Sanobharyang.

The study was performed on 66 upper limbs (33 right and 33 left), obtained from embalmed adult human

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cadavers of both sexes.⁵ Cadavers were randomly selected and numbered from 1 to 33 using a convenience sampling method. Cadavers with upper limb anomalies, decomposed tissues, or signs of injury to the upper limbs were excluded from the study. Right upper limbs were labeled 1R to 33R, and left upper limbs were labeled 1L to 33L.

Meticulous dissection of the axilla and anterior compartment of the arm was carried out following Cunningham's Manual of Practical Anatomy, Volume 1.⁶ The median nerve was observed for its site of formation, number of roots, and communications with other nerves in the axilla and arm. Special attention was given to communications between the median nerve and the musculocutaneous nerve in relation to the coracobrachialis muscle. Communications were classified as follows:⁷

Type 1- Communication proximal to the entry of musculocutaneous nerve.

Type 2- Communication distal to the exit of musculocutaneous nerve from coracobrachialis muscle.

Type 3- Musculocutaneous nerve did not pierce coracobrachialis directly or through its branches but ran alongside the muscle and exhibited a communication between it and the median nerve.

Type 4- The communicating branch along with musculocutaneous nerve pierced the coracobrachialis muscle following which the communicating branch joined the median nerve.⁸

All observed variations and communications of the median nerve were photographed. Data were recorded, tabulated and analyzed in SPSS™ version 20. Fisher's exact test was used to compare the difference in observations among right and left limb.

RESULTS

The study was conducted on 33 cadavers, comprising 23 males and 10 females. The smaller number of female cadavers was due to limited availability. The median nerve was observed to be formed in the axilla in 52 upper limbs (78.78%) and in the arm in 14 upper limbs (21.22%) (Table 1).

Table 1. Variations in Formation and Communication of the Median Nerve (N = 66 upper limbs).

Observations	Median Nerve Formation	Side	Frequency (%)	p value
Formation in Axilla (Relation to Artery)	Around 2nd part of axillary artery	Right	9 (27.3%)	0.648
		Left	10 (30%)	
	Anterior to 2nd part of axillary artery	Right	0 (0%)	
		Left	1 (3%)	
	In front of 3rd part of axillary artery	Right	15 (45.5%)	
		Left	17 (51.5%)	
Formation in Arm (Relation to coracobrachialis Muscle)	Proximal to muscle insertion	Right	8 (24.2)	0.672
		Left	5 (15.2%)	
	Distal to muscle insertion	Right	1 (3%)	
		Left	0 (0%)	
Median nerve formed from 2 roots (Axilla and arm)		Right	29 (87.9%)	0.672
	Left	31 (93.9%)		
Median nerve formed from 3 roots (Axilla and arm)		Right	3 (9.1%)	0.672
	Left	2 (6.1%)		
Median nerve formed from 4 roots (Axilla and arm)		Right	1 (3%)	0.672
	Left	0 (0%)		
Communication: Median with Musculocutaneous nerve		Right	5 (15.2%)	1.00
	Left	4 (12.1)		
Communication: Median with Ulnar nerve		Right	1 (3%)	1.00
	Left	1 (3%)		

Table 1 shows the variations in formation and communication of median nerve in both limbs. When formed in the axilla, the median nerve was found in relation to the axillary artery. In 19 cases (36.54%), the nerve formed around the second part of the axillary artery, where the artery was anterior to the median nerve in one left upper limb. In 32 cases (61.53%), the nerve was formed by the union of two roots in front of the third part of the axillary artery. In one (1.93%) left upper limb from a male cadaver; the nerve was formed higher, at the apex of the axilla, behind the clavicle.

In cases where the nerve formed in the arm, its formation was observed in relation to the insertion of the coracobrachialis muscle. In one case, the nerve was formed distal to the muscle's insertion (Table 1).

Median nerves formed from two roots were found in 60 upper limbs (90.9%): 47 in the axilla (78.34%) and 13 in the arm (21.66%). Five median nerves (7.58%) were formed by three roots in the axilla (Figure 1). In all these cases, the third (accessory) root originated from the lateral cord (Figure 1). One case of median nerve formation from four roots was identified in the axilla (Figure 2). Upon extending the dissection into the posterior triangle of the neck to trace the origin of the additional roots, it was found that the lateral cord was a continuation of the anterior division of the upper trunk, while the anterior division of the middle trunk gave rise to two additional roots.



1. Biceps brachii muscle
2. Coracobrachialis muscle
3. Musculocutaneous nerve
4. Median nerve
5. Lateral root of median nerve from lateral cord
6. Medial root of median nerve from medial cord
7. Accessory root of median nerve from lateral cord
8. Ulnar nerve

Figure 1. Additional third root of median nerve from lateral cord.

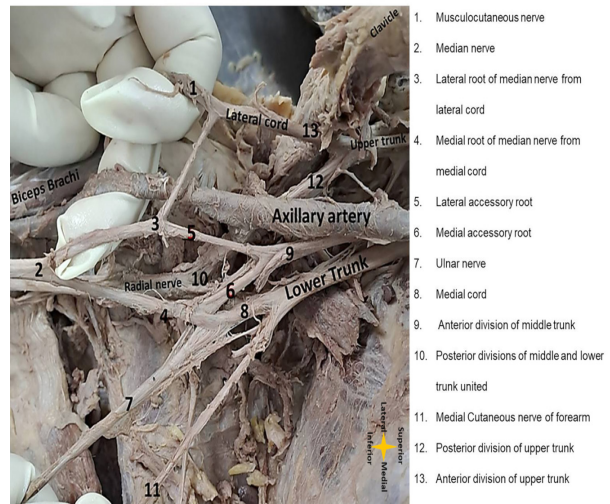


Figure 2. Supernumerary medial and lateral roots of median nerve from anterior division of middle trunk (Four Roots).

Communications between the median nerve and the musculocutaneous nerve (Figure 3; indicated by arrow) were observed in nine upper limbs (13.63%), while communication with the ulnar nerve (Figure 5; indicated by arrow) was found in two upper limbs (3.03%). In eight limbs, a single communicating branch emerged from the musculocutaneous nerve and joined the median nerve distally at the lower third of the arm.

Four limbs showed Type I variation (Figure 3), two limbs had Type II variation, and three limbs showed Type III communication (communication in relation to the coracobrachialis muscle). In one Type III communication, two separate branches emerged from both roots of the median nerve to innervate the brachialis muscle before communicating with the musculocutaneous nerve near the cubital fossa (Figure 4). Type IV variation was not observed.

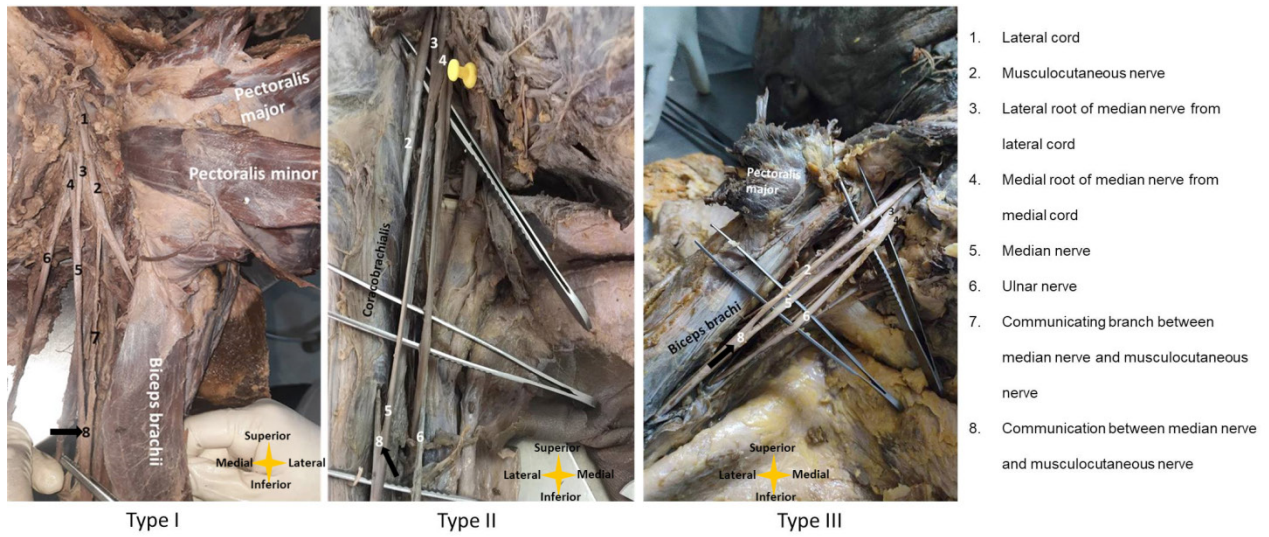


Figure 3. Different types of communications between median nerve and musculocutaneous nerve.

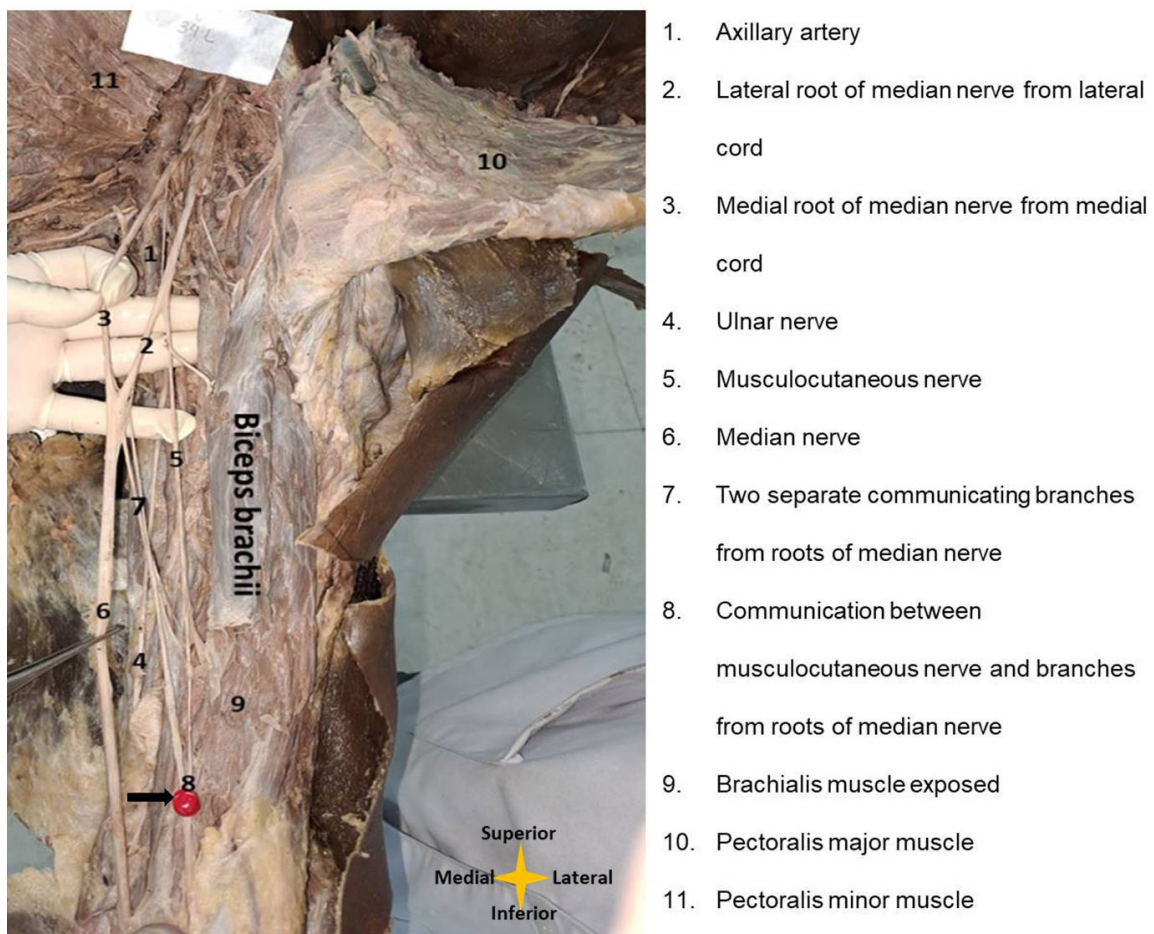


Figure 4. Type III communication between the median nerve and musculocutaneous nerve with additional branch from root.

Figure 5A shows a case of communication between the median and ulnar nerves, in which a branch from the ulnar nerve runs distally to join the median nerve at approximately the mid-arm level. Figure 5B illustrates a median nerve formed in the axilla with an additional root from the lateral cord that continues as a communicating branch to the ulnar nerve in the right upper limb.

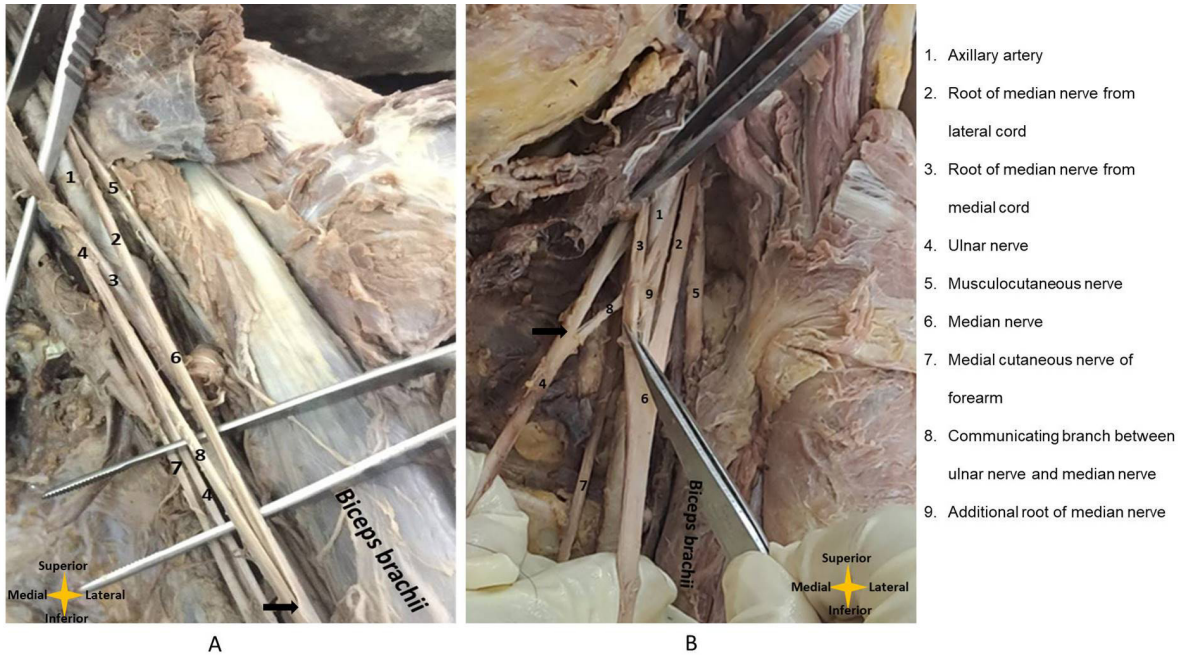


Figure 5. Communications between the median nerve and ulnar nerve.

In one left upper extremity, the musculocutaneous nerve was absent, and the muscles of the anterior compartment of the arm were innervated by branches from the median nerve. Additionally, the lateral cutaneous nerve of the forearm also originated from the median nerve. In this case, the ulnar nerve received an extra root from the lateral cord at the level of the axilla (Figure 6).

Fisher’s exact test was employed to compare the site of formation, the number of formative roots, and the communication of the median nerve with other nerves. The results of the test were not statistically significant (Table1).

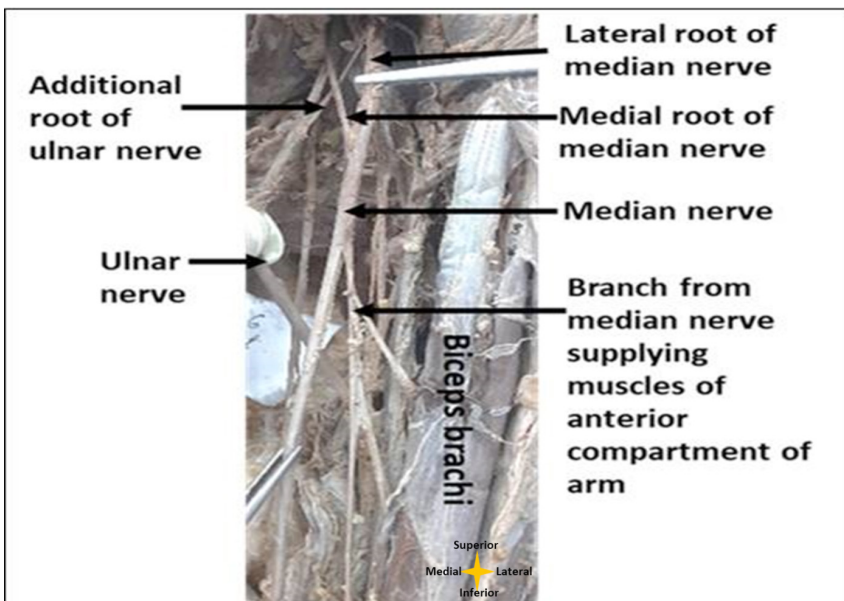


Figure 6. Musculocutaneous nerve missing with additional root of ulnar nerve

DISCUSSION

Morphological variations of formative roots and branching pattern of median nerve, as well as its site of formation, can be explained embryologically. These variations are regulated by expression of chemo attractants and chemo repellants between neuronal growth cones and mesenchymal cells of developing limb buds.⁹ Improper division of the nerve fibers at the different levels of brachial plexus during the time of development can lead to the communication between the nerve.¹⁰ Such developmental alterations may account for the unique finding observed in the present study, i.e. the presence of four roots contributing to the formation of the median nerve, arising from the middle trunk.

Normally, median nerve is formed in front of third part of the axillary artery; however, in the present study, its formation in the arm was also observed. Whenever the nerve is formed in arm the formative roots were found to be longer. Similar findings were also reported by Hada S et al. (8%), Manuel Encarnacion et al. (7.1%), Budhiraja V et al. (17.3%), Pattanshetti SV et al. (20%), and Akhtar MJ et al. (11.91%).^{3,5,11-13}

In the present study, the median nerve formed in the axilla was observed for its relation to axillary artery. A case was encountered where the median nerve formation and its course was posterior to the axillary and brachial arteries. Mat Taib CN et al. reported that the median nerve was running posterior to the axillary artery in 13.6% cases.¹⁴

Additional roots contributing to the formation of median nerve are also common findings. In our study, all additional third roots originated from the lateral cord of brachial plexus, unlike to the findings of Passey J et al., Manuel Encarnacion et al., Akhtar MJ et al., Mat Taib CN et al., and Ghosh B et al. Patil et al. also reported a third root arising from musculocutaneous nerve.^{2,5,13-16} In the present study, when a branch from the musculocutaneous nerve to the median nerve was observed, it was classified as Type I communication between them.

Formation of the median nerve from four roots was also described by Passey J et al., Hada et al., Manuel Encarnacion et al., Akhtar MJ et al., Mat Taib CN et al., Patil et al. Their findings showed that the two additional roots originated from the lateral cord and musculocutaneous nerve.^{2,3,5,13,14,16} In our study, however, the additional two roots arose from the anterior division of the middle trunk, which united with the medial and

lateral roots of median nerve. This finding has not been reported in previous studies.

Mat Taib CN et al., Patil et al., and Wozniak et al. reported cases of the median nerve forming from a single root as a branch from lateral cord.^{14,16,17} Natsis et al. described five roots of the median nerve, all three additional roots arising from the lateral cord.¹⁸ In our study, no cases of a single root or five root formation were observed.

One notable finding in our study was the absence of the musculocutaneous nerve. Mat Taib CN et al. also reported such an occurrence in two out of 44 upper limbs, where the musculocutaneous nerve was absent, and all the flexor muscles of the arm were supplied by the median nerve.¹⁴

Communication between nerves refers to the presence of an additional nerve branch connecting two or more trunks. Communication between the median and musculocutaneous nerves is more frequently observed compared to communications with other nerves in the arm. In our study, a branch was considered to be communicating if it connected another nerve to the trunk of the median nerve after its formation by the medial and lateral roots. If a branch was anastomosed with the roots of the median nerve, it was classified as a third (additional) root of the median nerve. Unlike our findings, where Type I communication was more frequent, Janani Y et al. and Khake SA et al. reported Type II communication as more common, followed by Type III and then Type I.^{10,19} Janani Y et al. and Arora et al. also reported two communicating branches between the median nerve trunk and the musculocutaneous nerve.^{10,20} Chauhan and Roy reported three, and Shukla et al. reported four such communications.^{21,22} In our study, two additional communicating branches from the roots of the median nerve were found to connect with the musculocutaneous nerve near the cubital fossa which is an observation not previously documented.

Clinically, abnormal communications and variations in the formative roots can be vulnerable to damage during the release of entrapment surgical procedures. Additional roots of the median nerve around any part of the axillary or brachial artery may also compress the vessels. A high formation of the median nerve in the axilla increases its vulnerability to injury during clavicle fractures or surgical procedures in the region. Additionally, the absence or variation of any component nerve may lead to failure of brachial plexus blocks. Although no correlation was found between nerve

variations and the side of the upper limb, such variations should be considered during anesthesia and surgical interventions to avoid undesirable complications in clinical practice.

CONCLUSIONS

Although the median nerve normally gives no branches in the arm, the present study suggests that additional roots and communications between the median nerve and other nerves are possible. The possibility of a missing musculocutaneous nerve and innervation of arm muscles by branches of the median nerve should be considered in neurophysiological studies, regional anesthesia, or nerve repair involving the axilla and arm. Hence, preoperative MRI/ultrasound screening for variations is advised in axillary surgeries to prevent iatrogenic injury.

Limitations: The anatomical variation observed in the present study was focused at the level of the origin of the median nerve and was based on a limited number of cadavers. Therefore, it is recommended that further studies be conducted along the entire course of the nerve, with correlation to relevant pathological conditions.

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