

# Branching Pattern of the Posterior Cord of the Brachial Plexus: A Cadaveric Study

PRITI CHAUDHARY, RAJAN SINGLA, GURDEEP KALSEY, KAMAL ARORA

## ABSTRACT

**Introduction:** Anatomical variations in different parts of the brachial plexus have been described in humans by many authors, although these have not been extensively catalogued. These variations are of clinical significance for the surgeons, radiologists and the anatomists.

**Material and Methods:** In a study of 60 brachial plexuses which belonged to 30 cadavers (male:female ratio = 28:02) obtained from the Department of Anatomy, Govt. Medical College, Amritsar, the brachial plexuses were exposed as per the standard guidelines. The formation and the branching pattern of the posterior cord have been reported here. The upper subscapular, lower subscapular, thoracodorsal and the axillary nerves usually arise from the posterior cord of the brachial plexus.

**Results:** normal branching pattern of the posterior cord was encountered in 52 (86.67%) limbs, the remaining 8 (13.33%) being variants in one form or the other. The upper subscapular nerve, the thoracodorsal nerve and the axillary nerve were seen to arise normally in 91.66%, 96.66% and 98.33% of the limbs respectively. The posterior division of the upper trunk being the parent of the variants of all these. The lower subscapular nerve had a normal origin in 96.66% of the limbs, with the axillary nerve being the parent in its variants, while the radial nerve had a normal origin in all of the limbs. Almost all the branches of the posterior cord emanated distally on the left side as compared to the right side.

**Conclusion:** The present study on adult human cadavers was an essential prerequisite for the initial built up of the data base at the grass root level.

**Key Words:** Posterior cord, Upper subscapular, Thoracodorsal, Lower subscapular, Axillary

## INTRODUCTION

The brachial plexus is a network of nerves which supply the upper limb with the root value C5-T1. These roots join with each other to form three trunks, each of which bifurcates into anterior and posterior divisions. These divisions reorient themselves to form lateral, medial and posterior cords, which give rise to different nerves for the upper limb.

Anatomical variations in different parts of the brachial plexus have been described in humans by many authors, although these have not been extensively catalogued [1, 2]. These may be due to an unusual formation during the development of the trunks, divisions, or cords [3] and they usually occur at the junction or separation of the individual parts [4, 5]. The clinical implications of these variations lie in the anaesthetic blocks and the surgical approaches to the region and the interpretation of a nervous compression which have unexplained clinical symptoms (sensory loss, pain, wakefulness and paresis, etc.) [6, 7].

For a surgeon, to have the variational patterns of the brachial plexus at his finger's ends is essential in the light of not only the frequency with which the surgery is performed in the axilla and the surgical neck of the humerus [8, 9] and the rapid development of microsurgical techniques [10] but also to give explanations when encountering an incomprehensible clinical sign [11].

The upper subscapular, lower subscapular, thoracodorsal and the axillary nerves usually arise from the posterior cord of the brachial plexus. But during a study which was performed on 60 upper limbs, different patterns of the origins of these nerves were observed which are being reported here. Further, an attempt was made to discuss their clinical significance.

## MATERIAL AND METHODS

The material for the present study comprised of 60 upper limbs which belonged to 30 adult human cadavers of known sex [ male: female ratio 28:02], which were obtained from the Department of Anatomy, Govt. Medical College, Amritsar. These were serialized from 1-30 with the suffixes 'M' for male, 'F' for female, 'R' for right and 'L' for left.

The brachial plexus was dissected and exposed according to the methods described by Romanes [12] in Cunningham's Manual of Practical Anatomy. All its roots, trunks, divisions, cords and branches were cleaned and the pattern of its formation and branching was seen. Out of all these, the formation and the branching pattern of the posterior cord has been reported here.

For measuring the lengths of different parts of the brachial plexus, a thread was kept along the length of that part and was marked with Indian ink at designated points. The thread which was thus marked, was lifted off the dissection area and spread along a graduated metric scale to measure the length. All the measurements were taken in cms.

## OBSERVATIONS

### 1. Formation

In 57 (95%) limbs, the posterior cord was formed in the usual pattern ie, by the union of the posterior divisions of the upper, middle and the lower trunk (C5-T1). In the other 3 limbs (Limb no. 8FL, 14ML and 16FL), there were 4 trunks instead of the usual 3 and these were numbered craniocaudally as trunk I, II, III and IV. Out of these, in 2 limbs (Limb no. 14ML, 16FL), the posterior cord was formed by the union of the posterior divisions of the I, II and

and IIIrd trunks ( root value- C5,C6; C7; C8 respectively; as whole of the IVth trunk (T1, T2) was continuing as the anterior division only, there being no posterior division) and in limb no. 8FL, the posterior cord was formed by the union of the posterior divisions of all the four trunks ie, trunks I, II, III and IV (root value- C4,5,6; C7; C8; T1,T2 respectively) .

## 2. Length of the Posterior Cord

The mean length of the posterior cord was 1.85 cm on the right side (range- 0.7-3.9 cm.) and 2.05 cm (range- 0.8-3.9 cm.) on the left side. However, in the 3 limbs on the left side ie, limb no. 8FL, 14ML and 16 FL which had 4 trunks, the length of the posterior cord was on a higher side, it being 3.0, 3.2 and 4.1 cms respectively.

## 3. The Branching Pattern

The normal branching pattern of the posterior cord was encountered in 52 (86.67%) limbs in the present study, the remaining 8 (13.33%) being variants in one form or the other.(vide infra)

### (i) The Upper Subscapular Nerve

In the present study, the upper subscapular nerve was seen to arise normally from the posterior cord in 55 (91.6%) limbs but in the remaining 5 limbs [08.33% (limb no. 4MR, 5ML, 11ML, 14MR and 15ML)], it originated from the posterior division of the upper trunk (root value C5,6).

### (ii) The Thoracodorsal Nerve

The thoracodorsal nerve depicted a normal origin in 58 (96.67%) limbs in the present study, it being variant in 2 limbs [3.33% (limb no. 5ML and 14MR)], where it was seen to be coming from the posterior division of the upper trunk. (root value- C5,6)

### (iii) The lower subscapular nerve

The lower subscapular nerve took its abnormal origin from the axillary nerve in two limbs (3.33%) (limb no. 25MR and 29MR) in the present study, it being normal in the rest of the 58 (96.67%) limbs [Table/Fig-1].

### (iv) The Axillary Nerve

The axillary nerve, being normal in origin as one of the terminal branches of the posterior cord in 59 (98.33%) limbs in the present study, in one limb {limb no. 13ML, (01.66%)}, it was found to originate from the posterior division of the upper trunk (root value- C5,6) [Table/Fig-2].

An important observation of the present study was that all the variant origins of the different branches of the posterior cord were seen in the male sex only. The pattern in females was perfect as was described in the text books. Also, all the variants of the upper subscapular, the thoracodorsal and the axillary nerves took origin from the posterior division of the upper trunk but the variant lower subscapular nerve originated from the axillary nerve.

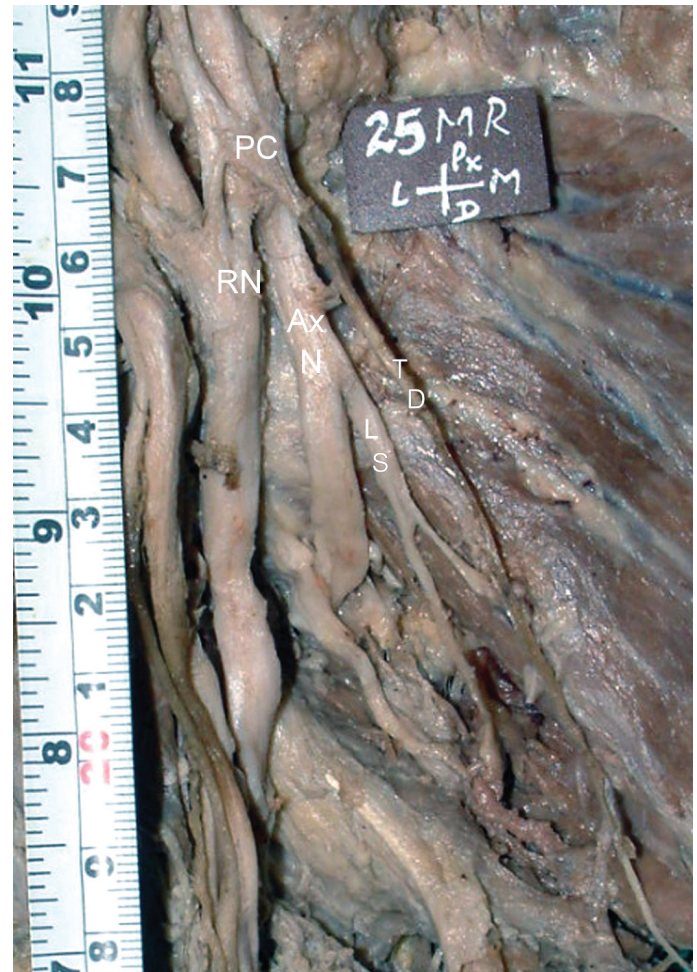
## 4. The Distances of Different Branches of the Posterior Cord from the Origin of the Parent Cord

[Table/Fig-3] depicts the distances of the different branches of the posterior cord from the origin of the parent cord.

It is evident from [Table/Fig-3] that the posterior cord gave off the upper subscapular nerve at an average distance of 0.95 cms. (Rt – 0.96 cms.; Lt – 0.95 cms.) from the point of its formation, the thoracodorsal nerve, at an average distance of 1.18 cms. (Rt – 1.10 cms.; Lt – 1.26 cms.) and the lower subscapular nerve,

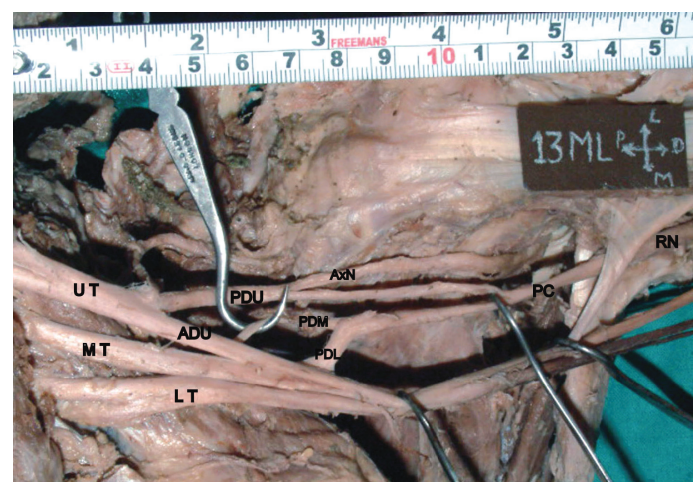
at an average distance of 1.47 cms. (Rt – 1.40 cms.; Lt – 1.55 cms.) from the point of its formation. Then, it bifurcated terminally into the axillary nerve and the radial nerve at an average distance of 2.02 cms. (Rt – 1.86 cms; Lt – 2.20 cms.) from the point of its formation.

However, the upper subscapular , the thoracodorsal and the axillary nerves which had their variant origin from the posterior



[Table/Fig-1]: (Cadaver/Limb No. 25MR)

Lower subscapular nerve (LS) arising from Axillary nerve (AxN)  
PC- Posterior cord; RN- Radial nerve; TD- Thoracodorsal nerve



[Table/Fig-2]: (Cadaver/Limb No. 13ML)

Axillary nerve (AxN) arising from posterior division (PDU) of upper trunk (UT). Posterior cord (PC) continuing as the radial nerve (RN).  
MT- Middle trunk; LT- Lower trunk; ADU- Anterior division of upper trunk; PDM- Posterior division of middle trunk; PDL- Posterior division of lower trunk.



| Sr No. | Branch of posterior cord | Distances of the branches in cms. |         |                  |               |         |                  |               |         |                  |
|--------|--------------------------|-----------------------------------|---------|------------------|---------------|---------|------------------|---------------|---------|------------------|
|        |                          | Right                             |         |                  | Left          |         |                  | Total         |         |                  |
|        |                          | Limbs studied                     | Range   | Average distance | Limbs studied | Range   | Average distance | Limbs studied | Range   | Average distance |
| 1.     | Upper sub scapular       | 28*                               | 0.1–2.9 | 0.96             | 27*           | 0.1–2.3 | 0.95             | 55            | 0.1–2.9 | 0.95             |
| 2.     | Thoraco dorsal           | 29*                               | 0.1–3.0 | 1.1              | 29*           | 0.1–3.0 | 1.26             | 58            | 0.1–3.0 | 1.18             |
| 3.     | Lower sub scapular       | 28**                              | 0.3–3.3 | 1.4              | 30            | 0.2–3.2 | 1.55             | 58            | 0.2–3.3 | 1.47             |
| 4.     | Axillary                 | 30                                | 0.7–3.9 | 1.86             | 29*           | 0.8–4.1 | 2.2              | 59            | 0.7–4.1 | 2.03             |
| 5.     | Radial                   | 30                                | 0.7–3.9 | 1.86             | 30            | 0.8–4.1 | 2.19             | 60            | 0.7–4.1 | 2.02             |

[Table/Fig-3]:

\*In the remaining limbs, these branches originated from the posterior division of the upper trunk; so not included here.

\*\*In the remaining 2 limbs it originated from the axillary nerve; so not included here.

division of the upper trunk, arose at an average distance of 2.0 cm., 2.15 and 3.40 cms respectively from the formation of the posterior division while the lower subscapular nerve arose from the axillary nerve at an average distance of 0.85 cm from the origin of the axillary nerve.

## DISCUSSION

### 1. Formation

According to the standard text books of anatomy by [13-20], the posterior cord is formed by the union of the posterior divisions of all the 3 trunks ie, upper, middle and lower. It was observed in 57 (95%) of our limbs. Earlier, **Kerr** [21] had also observed this in 69.71% of his dissections.

### 2. Length of the Posterior Cord

The length of the posterior cord was seen to be more on the left side (Rt- 1.85 cm.; Lt- 2.05 cm.), it being even higher in the 3 variant limbs on the left side having four trunks. No earlier study could be traced in the accessible literature to compare these findings.

### 3. The Branching Pattern

The posterior cord usually gives off the upper subscapular, the lower subscapular, the thoracodorsal, and the two terminal branches i.e. the axillary nerve and the radial nerve. The same pattern was encountered in 52 (86.67%) limbs in the present study and in the remaining 8 (13.33%) limbs, variations in one form or the other were encountered.

#### (i) The Upper Subscapular Nerve

The upper subscapular nerve usually arises from the posterior cord, but in the present study in 5 limbs [08.33% (R: L :: 2:3)], it originated from the posterior division of the upper trunk (root value C5,6). Earlier, **Kerr** [21] had come across such a variant origin in 25.4% of his dissections and **Fazan et al [22] & Ballesteros and Ramirez [23]** had come across such a variant origin in 59% and 50% of their dissections. No explanation can be given for such a wide discrepancy. **Fazan et al [22]** reported this variation to be more in males and on left side and same was found in our study also.

#### (ii) The Thoracodorsal Nerve

Again, a branch of the posterior cord usually in 2 limbs [3.33% (limb no. 5ML and 14MR)], was seen to be coming from the posterior division of the upper trunk. Only **Kerr** [21] has been able to find such a variant origin in 1.8% of his dissections, which is comparable to the 3.33% incidence found in the present study.

#### (iii) The Lower Subscapular Nerve

The lower subscapular nerve took its normal origin in 58 (96.67%) limbs but from the axillary nerve in 2 (3.33%) limbs (limb no. 25MR and 29 MR) in the present study at a distance of 0.2 cm and 1.5 cm respectively, from the origin of the axillary nerve. Earlier, **Kerr** [21], **Fazan et al [22]** and **Ballesteros and Ramirez [23]** had reported such an origin of the lower subscapular nerve from the axillary nerve in 43.31%, 54% and 54.4% of their dissections respectively.

#### (iv) The Axillary Nerve

In the sole limb {limb no. 13ML, (01.66%)} of the present study, the axillary nerve was found to originate from the posterior division of the upper trunk. Earlier, **Kerr** [21] had also found it to be so, in 9.2% of his dissections.

### 4. The Distances of Different Branches of the Posterior Cord from the Origin of the Parent Trunk

The mean value and the range of the distance of different branches of the posterior cord from the origin of the parent trunk on both the right and left sides are shown in [Table/Fig-3].

If we take a closer look at [Table/Fig-3], it can be seen that the distance of the origin of all the branches of the posterior cord (except the upper subscapular nerve) was more on the left side as compared to the right side, which means that the posterior cord gives its branches more distally on the left side than on the right side. In case of the upper subscapular nerve, the distance of the origin of this nerve was almost the same on the two sides.

Furthermore, as was discussed earlier, the average total length of the posterior cord was found to be more on the left side. This further supports our observations which are mentioned above. No earlier study could be traced in the accessible literature to compare these distances.

In the present study, though the sample size was small, every attempt has been made to discuss all the variants which were observed.

## SUMMARY AND CONCLUSION

To summarize, out of the 60 limbs dissected in the present study, the normal branching pattern of the posterior cord was encountered in 52 (86.67%) limbs, the remaining 8 (13.33%) being variants in one form or the other.

The upper subscapular nerve, the thoracodorsal nerve and the axillary nerve were found to arise normally in 91.66%, 96.66% and 98.33% of the limbs respectively. The posterior division of the

upper trunk being the parent of the variants of all these. The lower subscapular nerve had a normal origin in 96.66% of the limbs with the axillary nerve being parent in its variants while the radial nerve had a normal origin in all of the limbs.

All the branches of the posterior cord (except the upper subscapular nerve) emanated distally on the left side as compared to the right side, which means that the posterior cord gives its branches more distally on the left side than on the right side. The distance of the origin of the upper subscapular nerve was almost the same on the two sides. The average total length of the posterior cord was also more on the left side.

Eventually, it was concluded that the present study on adult human cadavers was an essential prerequisite for the initial built up of the database at the grass root level. Our findings were akin to the results of previous studies but with some variations. The human anatomy has always provided a bedrock for sound surgical endeavours. It definitely has an upper edge to widely and indiscriminately use radiological and sophisticated CT and MRI observations which carry a margin of error, which is inherent to any diagnostic procedure, because no doubt the machines are a good bet but the eyes see the best. Nevertheless, in the present times, a combined anatomical, radiological and MRI approach is the need of the hour. This combined effort could prove to be a torchbearer in the preoperative planning and in the final execution of the surgeries which are done in the axillary region.

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### AUTHOR(S):

1. Dr. Priti Chaudhary
2. Dr. Rajan Singla
3. Dr. Gurdeep Kalsey
4. Dr. Kamal Arora

### PARTICULARS OF CONTRIBUTORS:

1. Corresponding Author.
2. M.S. Anatomy, Associate Professor, Department of Anatomy Govt. Medical College, Amritsar, India.
3. M.S. Anatomy Professor & Head, Department of Anatomy, Genesis Institute of Dental Sciences & Research, Ferozpur, India.
4. M.S. Orthopedics, Medical Officer, Civil Hospital, Ferozpur, India.

### NAME, ADDRESS, TELEPHONE, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Priti Chaudhary, M.S., Anatomy  
Associate professor, Department of Anatomy  
G.G. S. Medical College, Faridkot  
E-mail: pritariorafdk@rediffmail.com  
Phone: 9855952965  
Fax: 01639251070

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