SHORT REPORT

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Unilateral multiple variations of the brachial plexus

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SUMMARY

Brachial plexus variations were encountered in the right upper limb of an adult male cadaver during the routine dissection course for undergraduate teaching at the Department of Anatomy, College of Medicine, King Saud University. The ventral rami of C4 and T2 were shared in the formation of the variant brachial plexus. The anterior and posterior divisions of the upper trunk fused with the middle trunk to form a single unit, which divided into anterior and posterior subdivisions. The posterior subdivision joined the posterior division of the lower trunk, forming the posterior cord and giving off the usual branches, while the anterior subdivision joined the anterior division of the lower trunk to form the anterior cord. No lateral or medial cords were found in this cadaver; only anterior and posterior cords, according to their relationship with the second part of the axillary artery. We also observed a medial pectoral nerve with two routes and the absence of a musculocutaneous nerve.

Key words: Nerve roots – Trunks – Divisions – Cords – Branches – Anatomical variations

INTRODUCTION

The brachial plexus is formed by the ventral rami of spinal nerves C5 to T1. Those of C5 and C6 unite to form the upper trunk. C7 continues as a middle trunk, while C8 and T1 form the lower trunk. These three trunks bifurcate into the anterior and posterior divisions. The posterior divisions of the three trunks unite to form the posterior cord. The anterior divisions of the upper and middle trunks unite to form the lateral cord, and the anterior division of the inferior trunk continues as a medial cord (Williams et al., 1995).

Variations of the brachial plexus are common (Miller, 1939; Tountas and Bergman, 1993). Twenty-nine types of brachial plexuses out of 175 were described by Kerr (1918). Uysal et al. (2003) observed 107 variations in 200 brachial plexuses dissected. An important aspect of the brachial plexus is knowledge of the variations in the formation of its roots, trunks, divisions, cords, and their distribution. The aim of this work is to report a case of the presence of only two cords —anterior and posterior— associated with other variations. Variations of the brachial plexus are of interest for anatomists, radiologists, anesthetist and surgeons because they may be vulnerable to damage in surgical operations of the

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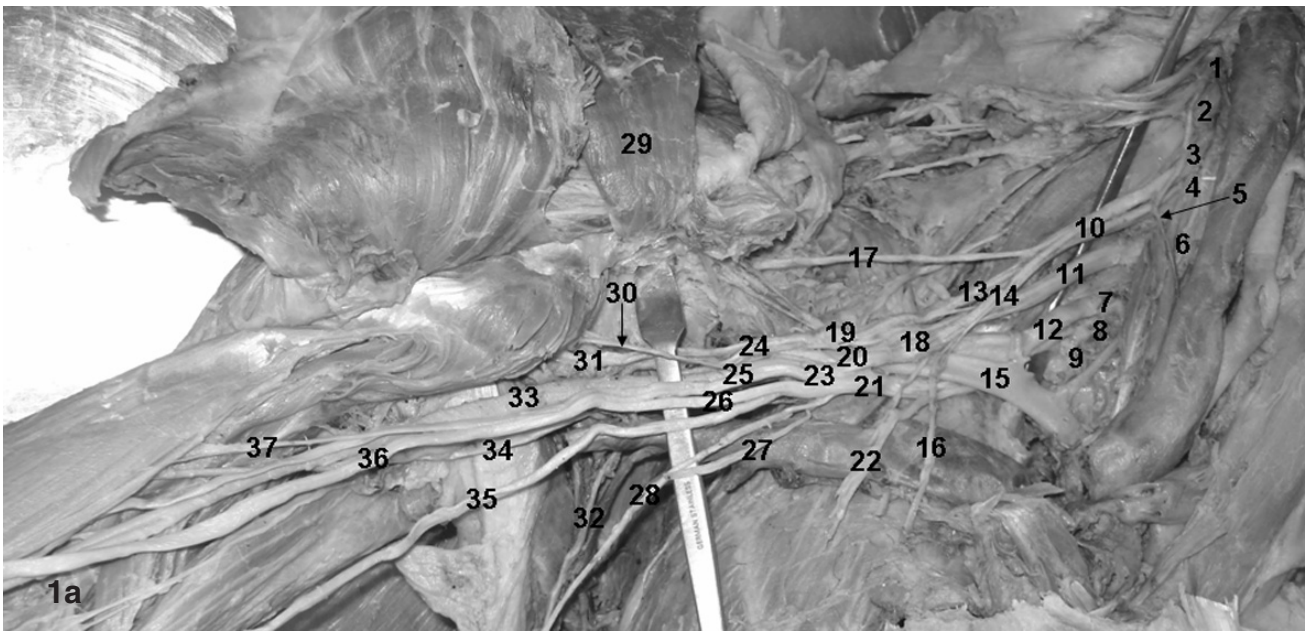

Fig. 1a. Right brachial plexus with scalenus anterior and subclavius muscles are cut and reflected. 1: C4; 2: Contributing branch of C4; 3: C5; 4:C6; 5: Phrenic nerve; 6: C7; 7: C8; 8: T1; 9: T2; 10: Upper trunk; 11: Middle trunk; 12: Lower trunk; 13: Posterior division; 14: Anterior division; 15: Subclavian artery; 16: Lateral pectoral nerve; 17: Subscapular nerve; 18: Unit; 19: Posterior subdivision; 20: Anterior subdivision; 21: Anterior division; 22: Medial pectoral nerve; 23: Anterior cord; 24: Posterior cord; 25: Lateral root of median nerve; 26: medial root of median nerve; 27: Medial cutaneous nerve of the arm; 28: Medial cutaneous nerve of the forearm; 29: Pectoralis minor; 30: Nerve to coracobrachialis; 31: Axillary nerve; 32: Thoracodorsal nerve; 33: Axillary artery; 34: Radial nerve; 35: Ulnar nerve; 36: Median nerve; 37: Nerve to biceps.

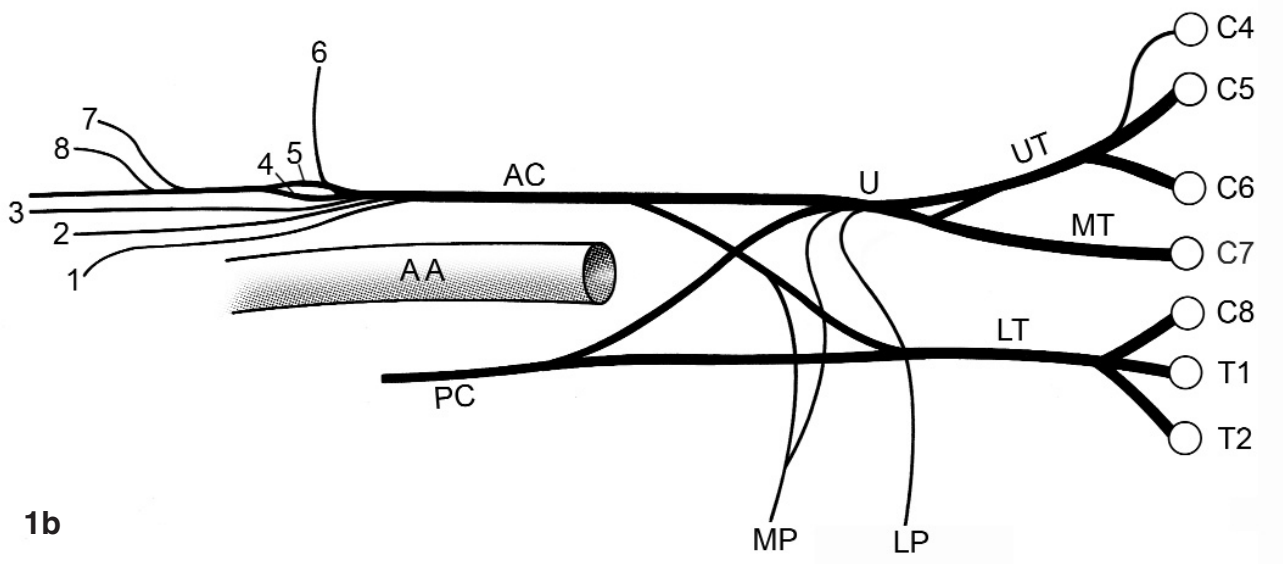

Fig. 1b. Schematic drawing of figure 1. UT: Upper trunk; MT: Middle trunk; LT: Lower trunk; U: Unit; LP: Lateral pectoral nerve; MP: Medial pectoral nerve; AC: Anterior cord; PC: Posterior cord; AA: Axillary artery; 1: Medial cutaneous nerve of the arm; 2: Medial cutaneous nerve of the forearm; 3: Ulnar nerve; 4: Medial root of median nerve; 5: Lateral root of median nerve; 6: Nerve to coracobrachialis; 7: Branch to biceps brachii; 8: branch to brachialis.

axilla and are of clinical significance in the diagnosis of nerve injuries. According to the literature reviewed, there are no previous reports available of the combination of such variations in a single case.

Case Report

Brachial Plexus variations were encountered in the right upper limb of an adult male cadaver during the routine dissection course for undergraduate teaching at the Department of Anatomy, College of Medicine, King Saud University. Important measures were taken to ensure careful dissection of the variant region. The clavicle was cut and removed, and the fascial sheath was peeled off to expose the brachial plexus clearly, and the relationships of its different sections were noted and photographed.

In the upper right limb of the cadaver of a 60-year old man, the ventral rami of C5 and C6 united to form the upper trunk with a contributing branch from C4. The C7 ventral ramus continued as a middle trunk, and the ventral rami of C8, T1 and T2 united to form the lower trunk. Both the upper and lower trunks divided into anterior and posterior divisions, while the distal part of the middle trunk failed to divide and was fused with the anterior and posterior divisions of the upper trunk, forming a single unit that gave off two branches: 1) The lateral pectoral nerve, and 2) A contributing branch to the medial pectoral nerve. Then, this unit subdivided into anterior and posterior subdivisions.

The posterior subdivision united with the posterior division of the lower trunk, passing posterior to the second part of the axillary artery and ultimately forming the posterior cord, which gave off five branches; the radial, axillary, thoracodorsal, upper subscapular and lower subscapular nerves. Its anterior subdivision united with the anterior division of the lower trunk, forming a single cord that passed anterior to the second part of the axillary artery, hence considered as an anterior cord (Fig. 1).

The anterior cord gave off five branches arranged from medial to lateral as follows: the medial cutaneous nerve of the arm; the medial cutaneous nerve of the forearm; the ulnar nerve; the medial root of the median nerve, and the lateral root of median nerve. The absence of musculocutaneous nerve was also observed (Fig. 1).

The biceps and brachialis muscles were innervated by branches of the median nerve, whereas the coracobrachialis received a branch from the lateral root of median nerve. The medial pectoral nerve had two roots: one from the single unit formed by the fusion of the middle trunk with two divisions of the upper trunk, and the other from the anterior division of the lower trunk. These were therefore the variations in the roots, divisions, cords and branches of the brachial plexus (Fig. 1).

Discussion

Anomalies of the brachial plexus and its terminal branches are not uncommon and have been widely documented (Kerr, 1918; Linell, 1921; Miller, 1939; Lee et al., 1992; Tountas and Bergman, 1993; Aktan et al., 2001; Uysal et al., 2003; Pandey and Shukla, 2007; Bergman et al., 1996).

The contributions of the C4 and T2 ventral rami to the brachial plexus are termed «prefixed» and «postfixed» respectively (Williams et al., 1995). Prefixed incidence is over 60% (Kerr, 1918; Tountas and Bergman, 1993; Bergman et al., 1996), although Lee et al. (1992) and Valeria et al. (2003) found its incidence to be much lower: 22.4% and 24% respectively. However, the presence of prefixed and postfixed rami together is rare. Lee et al. (1992) found only one such case out of 152 dissected. In the present study we observed both prefixed and postfixed together.

Uysal et al. (2003) reported the incidence of trunk variations to be 9%, in which the lower trunk failed to divide or was absent. Failure of the middle trunk to divide has been reported previously: it was either fused with the lower trunk (Kerr, 1918; Nakatani et al., 1998) or the upper trunk (Kerr, 1918), or the 3 trunks were fused together (Singer, 1933). In our case, the middle trunk failed to divide and was fused with the anterior and the posterior divisions of the upper trunk (Fig. 1). In cases where the brachial plexus is represented by two cords instead of three, the absent cord has been reported to be the posterior cord. The absence of the posterior cord has been reported previously (Kayode et al., 2007). Its reported incidence is 20% (Kerr, 1918), 3.5% (Pandey and Shukla, 2007). Furthermore, the absence of the lateral cord has also been reported, and failure of the contribution of the middle trunk to the lateral cord is considered to reflect the absence of the lateral cord (Kerr, 1918).

It has been proposed that in 20.57% of cases there is no real posterior cord (Kerr, 1918), but there seem to be no previous reports of two cords, as described in the present study (Fig. 1). A single cord of the brachial plexus has been reported previously (Singer, 1933), whereas variations in the cords and median nerve have been reported in 8.7% of axillae out of 344 dissected (Pandey and Shukla, 2007).

Nerves to the coracobrachialis from the lateral cord have been observed in 20% of cases studied (Kerr, 1918). This author also observed the fusion of the medial and lateral cords to form a common stem that in 3 cases immediately split into the median, ulnar and musculocutaneous nerves.

The absence of a musculocutaneous nerve has been reported previously (Tountas and

Bergman, 1993; Nakatani et al., 1997; Rao and Chaudhary, 2001). Innervation of the biceps muscle by the musculocutaneous nerve is classified in three types (Yang et al., 1995; Chiarapattanacom et al., 1998). In the present study, the musculocutaneous nerve was absent and the coracobrachialis muscle received a branch from the lateral root of the median nerve. The biceps and brachialis muscles were innervated by two separate branches from the median nerve (Fig. 1).

Three cases of medial pectoral nerve having two roots have been reported previously (Kerr, 1918).

Brachial plexus injuries affect slightly more than 1% of multiple-trauma victims, motorcycle and snowmobile accidents being of especially high risk (Midha, 1997). It has been proposed that these kinds of variations are vulnerable to damage in radical neck dissection and other surgical operations in the axilla and upper arm (Uzun and Seeling, 2001). The close relationship of the variant nerves with the axillary artery may result in its compression, leading to ischemic pain or varying degrees of arterial insufficiency during certain postural maneuvers of the shoulder joint (Saeed and Rufai, 2003).

Variant nerves having an abnormal origin, course and distribution are usually more prone to accidental injuries and entrapment neuropathies. It is also important to be aware of variations of the brachial plexus when performing anatomic, radiological, anesthetic and surgical procedures. It is essential to know such variations, especially with the widespread use of computerized techniques for diagnosis (Harry et al., 1997).

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References

Aktan Z, Ozturk L, Bilge O, Ozer M and Pinar Y (2001). A cadaveric study of the anatomic variations of the brachial plexus nerves in the axillary region and arm. *Turk J Med Sci*, 31: 147-150.

Bergman RA, Afifi AK and Miyauchi R (1996). Brachial Plexus: Illustrated encyclopedia of human anatomic variation opus II, Neuro: upper limb [updated 2005 January]. Available from: http://www.anatomyatlases.org/AnatomicVariants/NervousSystem/Text/BrachialPlexus.shtml

Chiarpattanakom P, Leechavengvongs S, Witoonchart K, Uerpairojkit C and Thuvasethakul P (1998). Anatomy and internal topography of the musculocutaneous nerve: the nerves to the biceps and brachialis muscle. *J Hand Surg*, 23: 250-255.

Harry WG, Bennette JD and Guha SC (1997). Scalene muscles and the brachial plexus: anatomical variations and their clinical significance. *Clin Anat*, 10: 250-252.

Kayode A, Olamide A, David A, Christina A, Victor O, Ferdinand A and Blessing I (2007). Abnormal pattern of brachial plexus formation: An original case report. *Int J Neurosurgery*, 4: 1-5.

Kerr AT (1918). The brachial plexus of nerves in man: The variations in its formation and branches. *Am J Anat*, 23: 285-392.

Lee HY, Chung IH, Sir WS, Kang HS, Lee HS, Ko JS, Lee MS and Park SS (1992). Variations of the ventral rami of the brachial plexus. *J Korean Medical Sciences*, 7: 19-24.

Linell EA (1921). The distribution of nerves in the upper limb, with reference to variabilities and their clinical significance. *J Anat*, 55: 79-112.

Midha R (1997). Epidemiology of brachial plexus injuries in a multitrauma population. *Neurosurgery*, 40: 1182-1189.

Miller RA (1939). Observations upon the arrangement of the axillary artery and brachial plexus. *Am J Anat*, 64: 143-163.

Nakatani T, Tanaka S and Mizukami S (1997). Absence of the musculocutaneous nerve with innervation of coracobrachialis, biceps brachii, brachialis and the lateral border of the forearm by branches from the lateral cord of the brachial plexus. *J Anat*, 191: 459-460.

Nakatani T, Tanaka S and Mizukami S (1998). Two rare anomalies of the brachial plexus. *J Anat*, 192: 303-304.

Pandey SK and Shukla VK (2007). Anatomical variations of the cords of the brachial plexus and the median nerve. *Clin Anat*, 20: 150-156.

Rao PV and Choudhary SC (2001). Absence of musculocutaneous nerve: Two cases. *Clin Anat*, 14: 31-35.

Saeed M and Rufai AA (2003). Median and musculocutaneous nerves: variant formation and distribution. *Clin Anat*, 16: 453-457.

Singer E (1933). Human brachial plexus united into a single cord. *Anat Rec*, 55: 411-419.

Tountas CP and Bergman RA (1993). Anatomic variations of the upper extremity. Churchill Livingstone, pp 193-210.

Uysal II, Seker M, Karabulut AK, Buyukmumcu M and Zialan T (2003). Brachial plexus variations in human fetuses. *Neurosurgery*, 53: 676-684.

Uzun A and Seeling LL Jr (2001). A variation in the formation of the median nerve: communication branch between the musculocutaneous and median nerves in man. *Folia Morphol*, 60: 99-101.

Valeria PSF, Andre DSA, Adilson L and Caleffi OAR (2003). Brachial plexus variations in its formation and main branches. *Acta Cirurgica Brasileira*, 18: 14-18.

Williams PL, Bannister LH, Berry MM, Collins P, Dyson M, Dussek JE and Ferguson MWJ (editors) (1995). *Gray's Anatomy*. 38th ed. Churchill Livingstone, New York, pp 1266-1274.

Yang Z, Pho RWH, Kour A and Preira BP (1995). The musculocutaneous nerve and its branches to the biceps and brachialis muscles. *J Hand Surg*, 20A: 671-675.