Some Variations in the Formation of the Brachial Plexus in Infants*

Ahmet UZUN1
Sait BİLGİÇ 2

Received: June 23, 1998

1Department of Anatomy, Inonu University, School of Medicine, 44100 Malatya-Turkey
2Department of Anatomy, Ondokuz Mayıs University, School of Medicine, 55139 Samsun-Turkey

Introduction

The anatomical variations of the brachial plexus in human have been well described by many authors (1-5). The brachial plexus is a complex of nerves originating in the neck and axilla. It is formed by the union of the ventral rami of the fifth, sixth, seventh, and eighth cervical, and the first thoracic spinal nerves. This nerve plexus can receive small contributing branches from the ventral primary ramus of the fourth cervical (C4) or the second thoracic (T2) spinal nerves (2,3,6). The human brachial plexus has three trunks (upper, middle, and lower) and three cords (medial, lateral, and posterior) which divides into nerves of the upper extremities (7-9).

As the embryonic somites migrate to form the extremities, they bring their own nerve supply, so that each dermatome and myotome retains its original segmental innervation. Throughout somite migration, some of the nerves come into close proximity and fuse in a particular pattern, forming a plexus early in fetal life. However, the inclination of the neurovascular bundle changes with growth and relative elongation of the neck and alterations of the ribs (10-12). Its location and osseous relations make the plexus vulnerable to damage by traction (10,13), especially during routine neck dissection (14), penetrating wounds, compression from cervical ribs, or damage to related vertebrae (15,16).

We have performed 130 anatomic dissections on 65 infants and present some variations of the human brachial plexus. These kinds of variations could be vulnerable to damage in radical neck dissections and in other surgical operations of the axilla.

Material and methods

The study was carried out in 130 brachial plexus of 65 newborn cadavers (34 males, 31 females; aged 1-7 days). All infant cadavers were supplied from the maternity hospital. All infants included in this study were born at term with no obvious external malformations. The cause of death was unknown. They were fixed in 10%

Abstract: The anatomical variations of the brachial plexus in human have clinical significance to surgeons, radiologists and anatomists. We studied some variations in the formation of 130 brachial plexuses in sixty-five infant cadavers (34 males, 31 females; aged 1-7 days). The brachial plexus consisted of the 5th, 6th, 7th, and 8th cervical spinal nerves and 1st thoracic spinal nerve (69.23%). We found that among the 130 plexuses, 30.77% also received a contribution from C4 (Fig.1, A). The variations in the formation of brachial plexuses were classified into three groups. Group 1 had a variation in the formation of the median nerve (10.77%), with fusion of three branches; one each coming from the lateral and medial cords; and one coming directly from a branch of the anterior division of the middle trunk (Fig.3,A). Group 2 had three anterior division cords: a) the lateral cord formed from anterior division of the upper trunk (Fig.2, A); b) an “intermediate” cord formed from the anterior division of the middle trunk and c) the medial cord formed from the anterior division of the lower trunk (3.07%). In group 3, there was a rare variation of the medial cord (1.54%) which receives an anastomotic branch from the posterior division of the middle trunk (Fig.4, B). The anomalies of the human brachial plexus have clinical importance in diagnosis of injuries of the brachial plexus.

Key Words: Gross anatomy, brachial plexus, variations, infant cadavers

* This study was presented at 3rd European Congress of Clinical Anatomy, Innsbruck, Austria, 1995
formalin, and the plexus dissections were carefully performed under a 4.8 X stereomicroscope (Carl-Zeis) or 28 X loop magnification. The formation and course of the plexus were traced to its branches in the distal arm. The length and diameter measurements of the roots of the brachial plexus were done under a 4.8 x stereomicroscope which has a ruler ranging from 1 to 12. The obtained results were transformed into millimetric system by the help of micro-optic disc. All photographs of the brachial plexus were taken during the dissection.

Results

One hundred thirty plexuses (65 infants) were dissected, and showed some variations in the formation of the brachial plexus. Ninety brachial plexuses (69.23%) originated from the ventral rami of the fifth, sixth, seventh, and eighth cervical spinal nerves and the first thoracic spinal nerve. Cervical spinal nerves C5 and C6 unite to form a common stem, the upper trunk. The eighth cervical and the first thoracic spinal nerves unite to form a lower trunk while the seventh cervical nerve remains independent and forms the middle trunk. In 20 of the 65 infants (30.77%), a variant connection between the fourth cervical and the fifth cervical spinal nerves was demonstrated on the right side and the left sides (Fig. 1). The contribution from C4 to C5 was 25 mm long and 0.1 mm in diameter. The diameter of the roots measured from, 1.1 to 1.57 mm (C5 = 1.1, C6 = 1.45, C7 = 1.57, C8 = 1.27, T1 = 1.1 mm). The length of the roots ranged from 5.53 to 10.52 mm (C5 = 10.52, C6 = 8.19, C7 = 6.77, C8 = 6.21, T1 = 5.53 mm). In this study, no contribution was observed connecting the second thoracic spinal nerve to the brachial plexus. In 126 plexuses (96.93%), the lateral cord was formed by a union of the ventral divisions of the upper and middle trunks.
In four plexuses (3.07% on the right side), the lateral cord was only formed from the ventral division of the upper trunk. In these four plexuses we observed a variation in the formation of the median nerve. The median nerve was formed by fusion of three branches; one coming from two lateral radix branches of the lateral cord; one intermediate radix directly from the middle trunk; and the normal medial radix from the medial cord (Fig. 2). These findings were symmetrical in the two cadavers. In 14 of the 130 plexuses (10.77%), there was a connection between the medial radix of the median nerve and the ventral division of the middle trunk (Fig. 3). Two of the plexuses (1.54% on the left side) had a branch which arose from the posterior division of the middle trunk and connected to the medial cord (Fig. 4). The distribution as to sex and side of the body of the observed variations are summarized in Table 1. These results suggest that variations in the formation of the brachial plexus are not influenced either by sex or body side.

<table>
<thead>
<tr>
<th></th>
<th>Male Number</th>
<th>Female Percent(%)</th>
<th>Male Number</th>
<th>Female Percent(%)</th>
<th>Male and Female Number</th>
<th>Percent(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>16</td>
<td>27</td>
<td>14</td>
<td>23</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>Left</td>
<td>12</td>
<td>20</td>
<td>18</td>
<td>30</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>Total</td>
<td>28</td>
<td>47</td>
<td>32</td>
<td>53</td>
<td>60</td>
<td>100</td>
</tr>
</tbody>
</table>
Discussion

The brachial plexus is a large and very important plexus that is situated partly in the neck and in the axilla (10). Although the plexus is normally formed from ventral rami C4 to C8 and T1, small contributions may come from the ventral rami of C4 or T2 (2,4,6). Variations in the pattern of the plexus can be due to abnormal formation in the development of the trunks, divisions, or cords (3). The more common variations in the brachial plexus are in its gross form at the level of the junction or separation of its component parts. Aside from improper distribution of cords which often introduce no change in the segmental origin of the branches (11). Walsh (5) was the first, who described anatomical variations in the formation of the brachial plexus in man. He reported an abnormal brachial plexus in 2 of the 350 plexuses. Kerr (2) reported that among 175 plexuses studied, 62% received nerve fibers from C5 to C6. Cunningham (17) found fibers of the second thoracic spinal nerve joining to the first in 27 out of 37 cases. Harman (18) also found similar connections in 7 out of 12 dissections, and Paterson (19) reported the same distribution in 11 out of 33 cases. Harris (6) stated that only in the postfixed types (the postfixed plexus only forms from the 5th, 6th, 7th, 8th, and T1) it might be expected that the second thoracic spinal nerve would join to the first and contribute to the plexus. In his report, the prefixed plexus (which forms from 4th, 5th, 6th, 7th, 8th, and T1) was noted in about one fifth (21.5%) of instances and the postfixed plexus was found in only one instance. Lee et al. (20) studied variations of the ventral rami of the brachial plexus in 77 Korean adults and found that of 152 brachial plexuses only 21.7% received a fiber from C4 to C6. In addition, of 117 plexuses only one case received a fiber from T2.

In 40 of the 130 plexuses in the present study, we observed connections from C4 to C6 (30.77%). These were all in the prefixed plexuses. We did not observe any connections from T2 to T1. Kerr (2) also noted an anomaly in the formation of the cords of the plexus. The lateral cord apparently contained fibers from the 4th, 5th, 6th, and 7th cervical spinal nerves. In 3 of 175 cases, the lateral cord also received a contribution from the lower elements (one case from the lower trunk, and 2 from the eighth cervical spinal nerve). In our study, the lateral cord was often formed by the 4th, 5th, 6th, and 7th cervical spinal nerves (30.77%). However, in 86 plexuses, the lateral cord contained fibers from the 5th, 6th, 7th cervical spinal nerves and in 4 plexuses, the lateral cord only contained the anterior divisions of C6 and C8 of the upper trunk (3.07%). According to Hollinshead (11), the medial cord of the brachial plexus typically represents only the continuation of the anterior division of the lower trunk, which contains only the eighth cervical and first thoracic fibers. Kerr (2) also reported this to be the usual origin in 94.58% of his specimens but in 5 cases the medial cord received a contribution from the seventh cervical spinal nerve. In the present study, the medial cord was mainly formed by the anterior division of the lower trunk (99.46%). In 2 cases (1.54%), the medial cord received fibers from the posterior division of the middle trunk. The median nerve usually has two roots, one of them from the lateral and the other one from the medial cords. Some variations in the formation of the median nerve have been described in textbooks of anatomy and surgery (7,8,11,21,22). In four of our 130 plexuses, the median nerve was formed by the union of three branches; two of them coming from the normal medial and lateral cords and one from the branch of the anterior division of the middle trunk.

Variations of the brachial plexus are often accompanied by abnormalities of vessels. This type of variation in the formation of the brachial plexus has been described by many authors (11,23,24,25). The upper extremity in the human is supplied by the axillary artery, and has an association to the division of the cords (25). During development, this artery derives from the 7th segmental artery and normally passes between the medial and lateral cords (26). However, if it originates from the 9th segmental artery, it can pass inferior to the medial cord (27,28). Thus, if the axillary artery had abnormal relations to the brachial plexus, the division of the cords would be modified by the presence of the abnormally placed artery. In our study, no apparent vascular varieties were demonstrated in the path of the axillary artery.

It can be said that anomalies of the brachial plexus can be found with vascular anomalies. As a conclusion, the anatomical variations of the human brachial plexus are very important to note during neck dissections where these unusual distributions can be prone to damage. They may also have clinical importance in diagnosis of injuries of the plexus.

Correspondence to:
Ahmet UZUN
Assistant Professor
Inonu University, School of Medicine
Department of Anatomy
44100-Kampus / Malatya, Turkey
References