Abstract: Objectives: Brachial plexus, a nerve plexus, that supplies the upper limb. Very few studies have been conducted in the fetus to know its pattern of variations. Therefore, this study aimed to identify the variations in the brachial plexus in human fetuses. Materials and method: Twenty-five formalin-fixed human fetuses were dissected bilaterally and the variations in the roots, trunks, cords and branches were identified. Results: Out of the fifty brachial plexuses studied, thirty-five plexuses were normal and fifteen showed variations. Among the fifteen variant plexuses, more number of variations were seen in the median nerve branch of the lateral cord of brachial plexus. These variations in the fetuses show that the adult pattern of variations are pre-determined in the embryological life. Conclusion: Therefore, these variations are of clinical importance for the clinicians and surgeons performing surgeries in the region of the axilla and in the upper limb.

Key Words: Brachial plexus, Cords, Fetus, Roots, Median nerve

Introduction: The brachial plexus is a somatic plexus formed by the anterior primary rami of C5 to C8 and T1. A limited contribution is also given by C4 and T2. The plexus originates in the neck, passes lateral and inferior to the first rib, and enters the axilla. The parts of the brachial plexus, from medial to lateral are, roots, trunks, divisions, and cords. All major nerves that innervate the upper limb originate from the brachial plexus, mostly from the cords. The brachial plexus would be called as pre-fixed if there is excessive contribution from C4 and the contribution from T1 is suppressed. Similarly, the brachial plexus would be called post-fixed when there is more contribution from T2 and least contribution from C5. A complex interchange of branches, before the main nerves of the upper limb are formed, produces its trunks, divisions, and cords [1].

A lot many studies regarding the variations in brachial plexus have been conducted on adult cadavers [2-5]. However, there is a paucity in the fetal study. Embryologically, the formation of brachial plexus is completed by the 13th week of gestation [6, 7]. Thereafter, there would only be growth along with the lengthening of the body of the fetus. Therefore, this project aims at viewing any morphological and/or anatomical deviations from normal by dissecting a total of 25 fetuses from the second and third trimesters.

Objectives

There is seen to be a considerable amount of variations in the brachial plexus, and a dissection of a total of 25 fetuses is to be made to come up with a conclusive result. The variations thus seen will be photographed. The objective here, is to determine the possible variations occurring in the brachial plexuses of developing fetuses. The variations due to clinical mishandling and/or accidents are not included.

Materials and Methods

Twenty-five spontaneously aborted fetuses, irrespective of their sex, belonging to the second and third trimesters, were procured from the Department of Obstetrics and Gynecology, KMC, Manipal. These fetuses were stored in 10% formalin solution. The fetuses with any visible abnormalities/malformations were excluded from this study. Further study was conducted in the Department of Anatomy, KMC, Manipal. The dissection was carried out bilaterally to observe the possible variations in the supraclavicular and infraclavicular parts of brachial plexus. To achieve this, an S-shaped incision was made along the posterior border of sternocleidomastoid muscle until the upper border of clavicle to the coracoid process and then down into the deltopectoral groove. The scalenus anterior muscle acted as a guide, to identify the roots and trunks of brachial plexus. The trunks and divisions were traced laterally up to the clavicle. Further, the clavicle was partitioned with a bone cutter to observe the possible variations in the infraclavicular part of brachial plexus (cords and branches) in the axilla. The variations were photographed. The entire study period lasted for eight months.

Results

Out of the fifty brachial plexuses studied, variations were observed in fifteen brachial plexuses (30%). For reference purposes, a picture of a standard brachial plexus of the right side is as shown in Fig 1. The variations thus found are tabulated (Table 1).
Table 1. Variations of brachial plexus

<table>
<thead>
<tr>
<th>Variation</th>
<th>Age</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper trunk and lower trunk of brachial plexus (fig. 2)</td>
<td>3rd trimester</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2nd trimester</td>
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<tr>
<td>Prefixed brachial plexus (fig. 3)</td>
<td>3rd trimester</td>
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<td></td>
<td>2nd trimester</td>
<td>1</td>
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<tr>
<td>Two lateral roots of the median nerve originating from the lateral cord (fig. 4)</td>
<td>3rd trimester</td>
<td>3</td>
<td>1</td>
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<tr>
<td></td>
<td>2nd trimester</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Median nerve formation with multiple roots (fig. 5)</td>
<td>3rd trimester</td>
<td>1</td>
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<td></td>
<td>2nd trimester</td>
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<tr>
<td>Low formation of median nerve (fig. 6)</td>
<td>3rd trimester</td>
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<tr>
<td></td>
<td>2nd trimester</td>
<td>1</td>
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<tr>
<td>Communication between median &amp; musculocutaneous nerves (fig. 7)</td>
<td>3rd trimester</td>
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<tr>
<td></td>
<td>2nd trimester</td>
<td>1</td>
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</tbody>
</table>

Figure 1. Normal right brachial plexus

Figure 2. Right Brachial plexus showing two trunks

Figure 3. Left pre-fixed brachial plexus

Figure 4. Additional lateral root of median nerve from lateral cord

Figure 5. Median nerve formation with multiple roots
Variations in the distal branches of brachial plexus – Among the branches of brachial plexus, highest number of variations were found in the median nerve. Median nerve formed from three roots is the most widely found variation [13, 14, 7]. In the present study, similar variation was observed (2 lateral roots from the lateral cord and 1 medial root from the medial cord) in 6 brachial plexuses (fig. 4). A single case in the present study also found the formation of median nerve from multiple roots (fig. 5). More distal formation of median nerve was observed by Uysal et al., in about 8.5% cases [7]. In the present study, a single brachial plexus showed a similar finding (fig. 6). A few authors have also shown a communicating branch between median and musculocutaneous nerves [7, 12]. In the present study, a similar communication between median and musculocutaneous nerves was observed in 4 brachial plexuses (fig. 7).

**Conclusion**

The purpose is supposed to be a self-investigation, documentation and deeper understanding of the combinations of converging and diverging patterns of the brachial plexus. The knowledge of these variations would help surgeons to perform surgeries better in the cervical and axillary regions. The presence of all possible anatomical variations can also explain certain abnormal symptoms and would facilitate the localization necessary for diagnosis and treatment of those symptoms. Due to abnormal communications, the defined dermatomes may be blurred, and the patient may experience anaesthesia/pain in a different dermatome. Similarly, seemingly anomalous cases can be better diagnosed by knowing any possible occurrences of variations. Thus, a fair amount of clinical applications is also possible. In some cases, a worthy post mortem explanation may also be offered for the cause of abortion.

**References**
