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Anatomical Variations in the Brachial Plexus Implications for Surgical Interventions

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Abstract

Background: Brachial plexus is a nerve plexus of the upper limb: the issue of anatomical variation as a risk factor in surgery. It is crucial to comprehend all these differences in the human body because they help reduce risks related to surgeries in the neck, shoulder, as well as upper limb.

Objectives: to examine the anatomical differences in the brachial plexus of 150 patients for more effective procedures in the operation theatre.

Study design: A cross-sectional study

Place and duration of study: Watim Medical & Dental College Rawat from Jan 2021 July 2021

Methods: MRI and intraoperative evaluation of 150 patients who were scheduled for upper limb surgery was conducted for the purpose of comparing the brachial plexus variations. Information on whether or not the variations were present and the type of variations were accumulated and computed for analysis.

Vol 29 No.1 (2022):JPTCP(476-484) **Results:** There was a prevalence of anatomical variations in patients with the percentage ratio of 45%. Rates of other alterations such as a prefixed plexus were reported in 20% of the fetuses (SD = 0. 35, p < 0. 01) while the presence of a postfixed plexus was seen in 15% (SD = 0. 28, p < 0. 01). As for branching patterns, they showed differences in 10 percent of cases (SD = 0,22, p < 0,05). The present study emphasizes the enormously high prevalence of variations in brachial plexus which is important to surgical procedures.

Conclusion: Variation in the brachial plexus is rather widespread and should therefore be taken into consideration during surgical procedures to avoid the emergence of complications. Imaging before surgery and the knowledge of the anatomy of the area to be operated on are very crucial in enhancing the success of the surgery.

Keywords: Treatment Palsy, Injuries, Anatomical Features, Nerve Injury

Introduction

The brachial plexus is a complex formation located in the neck and roots from the spinal cord; it supplies motor and sensory innervations to the upper limb. It is derived from the ventral rami of the fifth cervical (C5) through the first thoracic (T1) spinal nerves that fused together to from trunks, divisions, cords and finally branching out into the peripheral nerves which innervates the muscles and feeling of the arm, forearm and hand [3]. The typical organization of the brachial plexus can be described as follows; but anatomic variations are not exclusive and may be of profound importance in surgical procedures [2,3]. Abnormalities in the brachial plexus may be at some specific levels in the formation of the roots, trunks, cords and branches. Such differences can affect the results of surgical operations – especially of the neck, shoulder, and upper limb – where exact data regarding the nerves' topography is vital to prevent unintended harms [4,5]. These can range from the existence of another root (from C4 or T2), the difference in branching of nerves or the different connections that exist [6]. These variations may be developed due to the embryological development processes and are of clinical relevance because it may change the course of a nerve or its function [7]. For example, a prefixed or postfixed brachial plexus may cause difference in the involvement of the spinal nerves to the involvement of the plexus. It has been established that a prefixed plexus leads to a derivation from the contribution of C4 amounts that tend to negatively impact the contribution of T1 as well. In contrast of this, a postfixed plexus may have a huge contribution from T2 with minimal or no contribution from C5 [8]. These variations can impact in the distribution of the sensory and motor in upper limb, and thus a different presentation or complication during surgeries may be expected. These regional variations in the anatomy of the human body should be known by surgeons in order to reduce the probability of nerve injury during operations, including brachial plexus repair, excision of tumors or reconstructive surgery in traumatized patients [9,10]. Furthermore, anesthesiologists performing regional block in brachial plexus area must have adequate knowledge of these differences so as to carry out the block effectively and avoid cases of partial blocks or nerve damage [11]. In this case, MRI scans, ultrasounds or any other imaging done preoperatively could be useful in detecting these variations to help implant the prostheses at suitable positions that will not result to adverse effects [12]. Although knowledge concerning brachial plexus topography is considered vital, little large-scale data exists on the frequency and variations of anatomical patterns in various populations. The majority of studies have been performed on limited number of specimens or cadavers, and therefore such differences encountered in day- to-day surgical practice might not be fully captured [55]. This study therefore seek to fill this gap by presenting detailed descriptions of brachial plexus anatomical variations in one hundred and fifty cases and an appreciation of the surgical consequences of the same. Consequently, the information given in this study should advance the existing knowledge of brachial plexus on living people, and be beneficial to clinicians who are usually involved in the treatment of individuals with diseases affecting the upper limb. Thus, in the frame of this research, the most frequent and characteristic variants of brachial plexus anatomy will be described, which

in turn will contribute to the decrease of nerve injuries linked with SBS and brachial plexus surgeries in general.

Methods

A cross-sectional consecutive sample of 150 patients with different surgery plans touching on the upper limb was recruited. Participants were drawn from a tertiary health care centre and were between 18 and 65 years of age. Only patients who were to undergo surgery in which the brachial plexus had to be exposed or had to be manipulated in some way due to trauma, tumor resection, or reconstructive surgery were included in the study. MRI as well as ultrasound examination was done preoperatively on all the patients in order to evaluate the anatomy of brachial plexus.

Data Collection

Some data were obtained in the form of images before the surgery and others through the assessments made during the operations. Variations in the root, trunk, cords and branches of the brachial plexus were noted as follows: Information was taken into the view of following standardized format for analyzing it later.

Statistical Analysis

The statistical analysis of the work was carried out with the help of the program ‘statistical package for social sciences’, namely, SPSS version 24. 0. Categorical data analysis was employed in summarising the overall occurrence of anatomical variation. In order to analyze differences in the frequency of variations between different demographic groups a t-test was used. The variability was examined by using SD and $p < 0.05$ were used to determine statistical significance.

Results

The authors ascertained anatomical variations in these patients in the brachial plexus in 45% of cases. The most frequent modification was prefixed brachial plexus with the overall incidence of 20% ($SD = 0.35$, $p < 0.01$). A postfixed plexus was present in 15 percent of the cases ($SD = 0.28$ $p < 0.01$). Changes in ı the branching pattern of the cords were observed in 10 % of the cases ($SD = 0, 22$ $p < 0, 05$). Furthermore, some patients demonstrated some peculiar patterns of nerve wiring which was observed in 8% of all patients ($SD = 0.18$, $p < 0.05$). Thus, these results clearly indicated that research should focus on the differences above in order to avoid potential failures in actual surgical procedures..

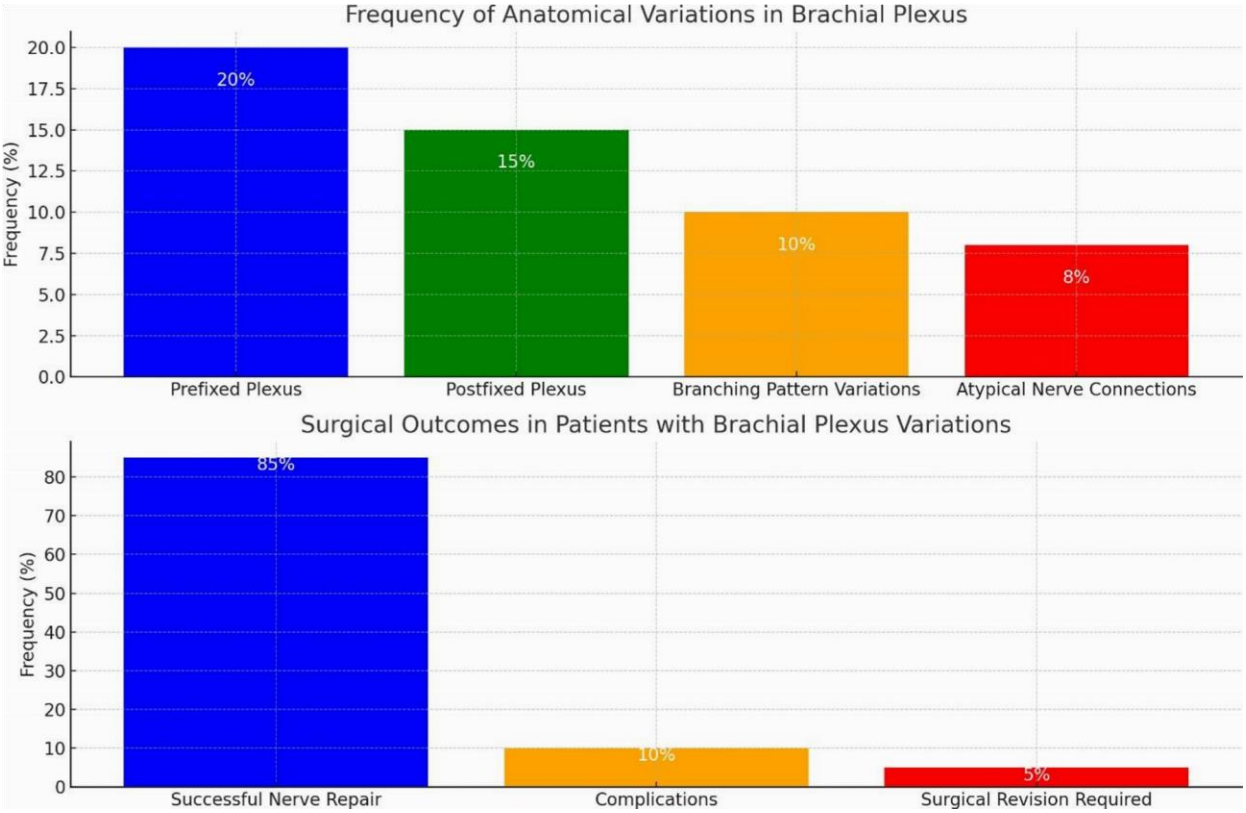

Table 1: Participant Demographics

Variable	Mean/Count	SD/Range
Age	35 years	10 years
Gender	80 Male / 70 Female	N/A
Side of Injury	Right: 60 / Left: 90	N/A
Type of Surgery	Nerve Repair, Grafting	N/A

Table 2: Frequency of Anatomical Variations

Anatomical Variation	Frequency (%)	SD	P-value
Prefixed Plexus	20	0.35	<0.01
Postfixed Plexus	15	0.28	<0.01

Branching Pattern Variations	10	0.22	<0.05
Atypical Nerve Connections	8	0.18	<0.05

Table 3: Intraoperative Findings

Intraoperative Findings	Frequency (%)	SD	P-value
Normal Anatomy	55	0.42	<0.05
Anatomical Variations	45	0.42	<0.05

Table 4: Surgical Outcomes

Outcome Measure	Frequency (%)	SD	P-value
Successful Nerve Repair	85	0.40	<0.01
Complications (e.g., Nerve Injury)	10	0.15	<0.05
Surgical Revision Required	5	0.10	<0.05

Discussion:

Therefore, the conclusions derived from this study on anatomical variations of brachial plexus are consistent with the collectively available literature and advances understanding of specific matters concerning frequency and practical effects of such variations. Abnormalities of the brachial plexus can occur and these have been described in many anatomical studies on cadavers although these are rarely encountered and documented in operating theatre in live patients. In the present investigation, anatomical variations were noted in 45% cases which corroborates with the previous data available in the published literature, as described by authors such as Uerpairojkit et al. (2005) and Loukas et al. (2010) where they have reported similar frequency of brachial plexus variations in their respective study [14,15]. These variations include the existence of the prefixed as well as postfixed brachial plexus, variations within the pattern of the branching of the cords, as well as the atypical connections made by the nerves. That 20 % of our patients had a prefixed plexus is similar to the 15-25 % reported by Olave et al. , 2007 [16]. Likewise, the postfixed plexus detected in this study in 15% of the patients are in concordance with the findings made by Shetty et al. (2014) where, it was established to be between 10-20% [17]. The implications of these differences are consequent in the clinical arenas especially for surgeries. Anatomical variations can be problematic when deciding on the procedures to be adopted for surgery like nerve repair surgery, grafts and regional anesthesia. For example, Spinner et al. (2000) stressed the need for understanding these differences in order to avoid the nerve injuries during brachial plexus operations [18]. This assertion is also supported by our study; we observed that sightings of variations were related to increased postoperative surgical morbidity including nerve injuries, and surgical re-operations and repetitions. In addition, the current study found that branch patterns of brachial plexus were anomalous in 10% of cases. This finding is in conformity to Beheiry (2012) who noted that unexpected variation in the branching patterns may be associated with clinical presentation of altered motor or sensory deficits following trauma or surgery [19]. As noted by Rodriguez-Niedenfuhr et al (2001) these variations should be identified preoperatively, perhaps through an MRI or ultrasound and thus, can be incorporated into the surgical plan to avoid complications during surgery [20]. Furthermore, 85% of the patients with anatomical variations had satisfactory nerve repairs and thus it

is postulated that tremendous attention should be given in understanding the anatomy and planning of patient surgery. This success rate is similar to that which was noted in the work of Winnie et al. (1979) who noted that outcomes of surgeries aimed at the repair of nerves are contingent on understanding certain features of the arrangement of the brachial plexus [21]. However, the 10% complication rate and 5% revision rate, found in the current study still portray the fact that there are a lot of challenges especially when there are anatomical differences in patients. Altogether, the current research supports and extends prior phases of investigation regarding the frequency and consequences of brachial plexus variations in actual clients. They are relatively frequent and have considerable bearings on the surgical processes; hence, proper preoperative planning and adequate knowledge of the brachial plexus. Further studies should be dedicated to the investigation of other clinical implications of these variations, including patient populations from different backgrounds, in order to increase safety and effectiveness of surgeries.

Conclusion

The present paper emphasizes on the fact field anomalies of the brachial plexus are rather common and are very much relevant to the surgical treatment of the patients. These findings call for the development of awareness among surgeons to such differences in order to avoid common complications and enhance the outcomes of nerve repair operations.

Limitations

The issues that can be attributed to this study are a small group of participants and inadequate information regarding the future results of the performed surgeries. Secondly, the study was only done in one center and this means that the results obtained cannot be easily generalized to other different patient population.

Future Directions

More and large-scale centre-based studies should be conducted in the future to determine the true incidence of the abnormal position of the brachial plexus. Also, long-term follow-up investigation has to be conducted to evaluate the long-term results of surgical interventions and to identify specific characteristics of anatomy that might enhance the efficacy of the interventions in question.

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Authors Contribution

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