Turk J Anaesthesiol Reanim 2017; 45: 164-8 DOI: 10.5152/TJAR.2017.33349

Original Article / Özgün Araştırma

Importance of the Upper Extremity Position for a Safe and Effective Axillary Block: a Comparative Study

Güvenli ve Etkili Bir Aksiller Blok İçin Üst Ekstremite Pozisyonunun Önemi: Karşılaştırmalı Bir Çalışma

Ömür Öztürk[1], Aysu Hayriye Tezcan[1], Ali Bilge[2], Esref Erdem[1], Hatice Yağmurdur[1], Burhan Dost[3]

[1]*Department of Anaesthesiology and Reanimation, Kafkas University School of Medicine, Kars, Turkey*

[2]*Department of Ortopedics and Traumatology, Kafkas University School of Medicine, Kars, Turkey*

[3]*Department of Anaesthesiology and Reanimation, Besni State Hospital, Adıyaman, Turkey*

Abstract / Öz

Objective: Our aim was to determine the ideal position of upper extremities during ultrasonography guidance for axillary block. The position that provides the shortest distance between the median and musculocutaneous nerves was assumed to be the most appropriate position for axillary block.

Methods: In this cross-sectional study, 120 (45 female and 75 male) patients were placed in a position with a shoulder at 90° / elbow 90° (position 1) and a shoulder 90° / elbow 0° (position 2). The intersection point of the biceps brachii muscle with the lower border of the pectoralis major muscle is defined as the proximal level (P). Distal level (D) is reffered as 5 cm below the proximal level. In the positions described above, the distance between median and musculocutaneous nerves was measured proximal (positions 1P and 2P) and distal levels (positions 1D and 2D). It was investigated whether these measurements differed between the groups and whether the body mass index or the gender.

Results: The shortest mean distance (10.24±3.95 mm) between the two nerves was determined when the shoulder position 90°/elbow position 0° at the distal level (1D) and the longest mean distance (13.41±4.26 mm) was determined when shoulder position 90°/elbow position 90° at the proximal level (2P). In all four cases, there was no difference in the results between men and women. There was no relationship between the measurement results and the body mass indexes and age of the patients.

Conclusion: Appropriate positioning of the upper extremities is important for achieving optimal position during axillary block. Thereby, the procedure can be safely and effectively performed with lesser amounts of local anaesthetic solution and a decreased number of manoeuvres with needle during infiltration.

Keywords: Axillary block, ultrasound guidance, median nerve, musculocutaneous nerve

Amaç: Amacımız, ultrason kılavuzluğunda yapılan aksiller blok sırasında üst ekstremitenin ideal pozisyonunu belirlemektir. Median ve muskulokutanöz sinirler arasında en kısa mesafeyi sağlayan pozisyonun aksiller blok için en uygun pozisyon olduğu varsayılmıştır.

Yöntemler: Bu kesitsel çalışmada 120 (45 kadın ve 75 erkek) hastada her bir kola omuz 90°/dirsek 90°'de (pozisyon 1) ve omuz 90°/dirsek 0°'de (pozisyon 2) olacak şekilde pozisyon verildi. Pektoralis major kasının alt sınırıyla biseps brachii kasının kesişme noktası proksimal seviye (P) olarak tanımlanmıştır. P'nin 5 cm distaline distal seviye (D) denilmiştir. Yukarıda anlatılan pozisyonlarda median ve muskulokutanöz sinirler arasındaki mesafe proksimal (pozisyon 1P ve 2P) ve distal seviyelerde (pozisyon 1D ve 2D) ölçüldü. Tüm bu ölçümlerin gruplar arasında farklılığı ve hastaların beden kitle indeksi yada cinsiyetiyle değişiklik gösterip göstermediği araştırıldı.

Bulgular: İki sinir arasındaki en kısa ortalama mesafe (10,24±3,95 mm) distal seviyede omuz 90°/dirsek 0° pozisyonda (1D), en uzun ortalama mesafe (13,41±4,26 mm) ise proksimal seviyede omuz 90°/dirsek 90° pozisyonda (2P) iken saptanmıştır. Dört durumda da sonuçlar açısından erkekler ve kadınlar arasında herhangi bir farklılık saptanmadı. Ölçüm sonuçları ile hastaların vücut kitle indeksleri ve yaşları arasında herhangi bir ilişki saptanmadı.

Sonuç: Aksiller blok sırasında optimal başarının sağlanması açısından üst ekstremitenin uygun pozisyona getirilmesi önemlidir. Böylece, işlem güvenle ve etkinlikle, daha düşük miktarda lokal anestezik kullanılarak ve infiltrasyon sırasında daha az ayıda manevra ile gerçekleştirilebilir.

Anahtar sözcükler: Aksiller blok, ultrason kılavuzluğu, median sinir, muskulokutanöz sinir

Introduction

Understanding peripheral nerve anatomy is necessary for an effective and safe nerve block. However, variation from standard anatomical organisation is relatively common, and localisation and identification of target nerves must be carefully and precisely made (1). Recently, the use of high-definition ultrasound has been popularised in peripheral regional anaesthesia (2).

Although ultrasound is used to directly visualise nerves and plexus, extremities must be maintained in certain positions for determining landmarks. For instance, the brachial plexus in the axillary region should be approached with the extremity positioned as described in relevant publications (3).

Address for Correspondence/Yazışma Adresi: Ömür Öztürk E-mail: dromur52@hotmail.com

Received / Geliş Tarihi : 17.01.2017
Accepted / Kabul Tarihi : 17.04.2017

Attributed to shoulder mobility, the brachial plexus at the axilla level is vulnerable for the re-arrangement of anatomical structures according to the position. Axillary brachial plexus block is one of the most frequently used methods of regional anaesthesia (4). Separate blockade of the four main brachial nerves (radial, median, ulnar, musculocutaneous) remarkably increases the success rates (5).

These nerves are arranged within a neurovascular sheath around the axillary artery. Nevertheless, the position of the nerves inside the sheath is not fixed and does not allow a certain extent of movement. Moreover, fibres, to a variable degree, are exchanged between individual nerves (3). Variability of the axillary fossa anatomy may challenge blockage of the main brachial nerves one by one. Interestingly, the radial, median and ulnar nerves are located in the common neurovascular sheath at the level of the pectoralis major and biceps humeri muscles intersection. This point is the frequent site of axillary brachial plexus block application (3).

For regional nerve blocks, the injection of a local anaesthetic must be administered as close to the nerves as possible. Thus, landmarks must be properly identified to ensure that all parts of the nerves are properly exposed to the anaesthesia (6). Determining the optimal position of the arm for visualisation of target nerves during ultrasound-guided axillary brachial plexus block may enhance the efficacy and safety of the procedure (3). Axillary nerve block may be performed via paraesthesia or trans-arterial techniques, as well as peripheral nerve stimulation or real-time ultrasound guidance. There has been no apparent superiority of any of these modalities, but specific blocking of the terminal nerves may improve success (7).

Localisation of the musculocutaneous nerve may be difficult based on simple anthropomorphic data. This point must be considered during ultrasound-guided axillary blocks and the use of nerve stimulation. Understanding peripheral nerve anatomy is essential for effective nerve block, and variations from standard anatomical organisation are not rare (1).

In this study, we investigated whether the anatomical course of median and musculocutaneous nerves changed with arm position in ultrasound guidance. Seconder aim of the study is to evaluate the impacts of different positions of upper extremity on the association between the median and musculocutaneous nerves and to assess whether this association is influenced by body mass index, age or gender.

Methods

Study design

This cross-sectional study was implemented in the anaesthesiology and reanimation department in a university hospital after the approval of local institutional review board. Written informed consent was obtained from each participant.

A total of 120 patients (45 women, 75 men) who were planned for axillary block were enrolled in the present trial. Exclusion criteria were age <18 years, restriction in shoulder movement, history of infection, trauma or surgery in the axillary region. Age and gender were recorded for every patient at the beginning of the study. The height and weight of all patients were measured and each patient's body mass index (BMI) was calculated (kg m^{-2-1}). BMI <18.5 kg m^{-2-1} defined as underweight, BMI between 18.5-25 kg m^{-2-1} defined as normal weight, BMI between 25-30 kg m^{-2-1} defined as overweight, BMI >30 kg m^{-2-1} defined as obese. Volunteers lay in the supine position for the ultrasonographic measurement of the axillary region. "Resolution mode" was selected on the ultrasound device for depth and gain after optimisation. A portable ultrasound machine (UEGO HM 70A, Samsung, Seoul, South Korea) and a 10-18 MHz linear multi-frequency probe were used. The probe was placed in vertical angle to the nerves, artery and humerus. It was noted not to press the skin with the probe to prevent from movement of nerves by compression to the veins and arteries. Each arm was placed in two different positions as shoulder 90°/elbow 0° (Position 1) and shoulder 90°/elbow 90° (Position 2). The intersection point of the biceps brachii muscle with the lower border of the pectoralis major muscle is defined as the proximal level (P). Distal level (D) is reffered as 5 cm below the proximal level. And two different measurement points (proximal and distal) were defined at these two positions. The distance between the median nerve and musculocutaneous nerve was measured with ultrasound in four different shoulder positions (position 1P, 1D, 2P, 2D) while the patients lay in the supine position (Figure 1, 2).

Statistical analysis

Data was analysed with IBM Statistical Package for Social Sciences Statistics 20 software (IBM SPSS Statistics; Armonk, NY, USA). The normality of distribution for the variables was tested with the Kolmogorov-Smirnov test. Comparison of dependent groups was made with the repeated measures ANOVA test. Homogeneous groups were compared with the Bonferroni test. Correlation between variables was evaluated with Pearson's correlation test. Comparison of two indepen-

Figure 1. Ultrasonic view of axilla in the proximal position. The median and musculocutaneous nerves were marked

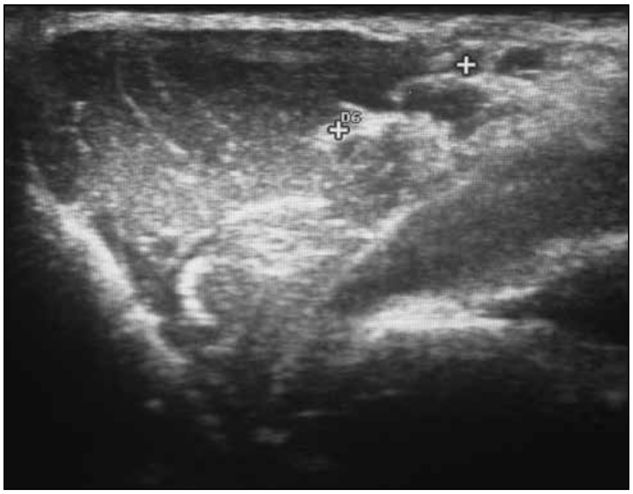

Figure 2. Ultrasonic view of axilla in the distal position. The median and musculocutaneous nerves were marked

Table 1. Comparison of measurements performed in two positions at the proximal (P) and distal (D) levels

Position	Position	p
Shoulder 90°/elbow 0° (P)	Shoulder 90°/elbow 0° (D)	<0.001*
	Shoulder 90°/elbow 90° (P)	1.000
	Shoulder 90°/elbow 90° (D)	<0.001*
Shoulder 90°/elbow 0° (D)	Shoulder 90°/elbow 90° (P)	<0.001*
	Shoulder 90°/elbow 90° (D)	0.009*
	Shoulder 90°/elbow 90° (P)	<0.001*

*statistically significant; P: proximal level; D: distal level

Table 2. Measurement results according to the four different points

Position and Level	Distance between nerves (mm)
Shoulder 90°/elbow 0°, proximal (1P)	13.28±4.22
Shoulder 90°/elbow 0°, distal (1D)	10.24±3.95
Shoulder 90°/elbow 90°, proximal (2P)	13.41±4.26
Shoulder 90°/elbow 90°, distal (2D)	10.91±4.22

dent groups was made with the independent samples t-test, while more than two dependent groups were carried out with the one-way ANOVA. Quantitative data was expressed as mean, standard deviation and minimum and maximum values. The confidence interval was 95%, and the level of significance was set at $p<0.05$. Since the assumption of sphericity was not met, the Greenhouse-Geisser correction was used to evaluate the difference within groups ($p<0.001$).

One-way α-value was 0.05; the β-value accepted as 0.20. The number of patients required for total patient as statistical 80% power should be at least 62, which is calculated by using the standard effect size according to the literature (STATISTICA 9.0 30-day trial version was used for calculating statistical power analysis.)

Table 3. Measurement results of the four different points according to the gender

Position	Gender	Distance between nerves (mm)	p
Shoulder 90°/elbow 0° (1P)	Men	13.46±4.31	0.55
	Women	12.98±4.11	
Shoulder 90°/elbow 0° (1D)	Men	10.50±4.07	0.36
	Women	9.81±3.74	
Shoulder 90°/elbow 90° (2P)	Men	13.10±4.10	0.30
	Women	13.93±4.52	
Shoulder 90°/elbow 90° (2D)	Men	10.97±4.12	0.82
	Women	10.79±4.23	

P: proximal level; D: distal level

Results

This study comprised 45 women (37.5%) and 75 men (62.5%). The average age was 46.62±15.61 (range, 21-85) years, and the average BMI was 26.42±5.48 (range, 16.34-44.97) kg m^{-2-1}. There were significant differences between the distances measured in the four distinct positions during ultrasonography for axillary block (Table 1). There were significant differences between the measurements made at proximal and distal levels. The shortest mean distance (10.24±3.95 mm) between two nerves was detected at position 1D, while the longest mean distance (13.41±4.26 mm) was noted in position 2P (Table 2).

According to Levene's test for equality of variances, there was no difference between men and women in terms of the results acquired in the four measurements (Table 3). Correlation analysis demonstrated that there was no association between the results of measurements and age or BMI (Table 4). Similarly, no difference could be detected between different BMI groups (underweight, normal, overweight and obese) and distances between the median and musculocutaneous nerves (Table 4).

Discussion

The study aimed to evaluate the distance between the median and musculocutaneous nerves in various positions of the shoulder and elbow. Our results suggest that shoulder 90°/elbow 0° position provides the smallest gap at the distal level. Hence, setting to this position of the patient's arm and adjusting the optimum ultrasound technique can facilitate axillary block and decrease the likelihood of risks during intervention.

Table 4. Comparative overview of distances between the median and musculocutaneous nerves measured in patients with various body mass index (BMI) groups. (Groups were constituted as follows: BMI<18.5: underweight; 18.5≤BMI<25: normal; 25≤BMI<30: overweight; BMI≥30: obese)

Position	Body mass index group	Distance (mm)	p
Shoulder 90°/elbow 0° (1P)	Underweight (n=3)	12.13±5.14	0.860
	Normal (n=42)	13.50±4.22	
	Overweight (n=51)	13.42±4.61	
	Obese (n=24)	12.75±3.41	
Shoulder 90°/elbow 0° (1D)	Underweight (n=3)	8.70±4.44	0.584
	Normal (n=42)	10.29±3.21	
	Overweight (n=51)	10.66±4.54	
	Obese (n=24)	9.46±3.82	
Shoulder 90°/elbow 90° (2P)	Underweight	13.83±6.88	0.805
	Normal	13.00±3.55	
	Overweight	13.84±4.73	
	Obese	13.17±4.26	
Shoulder 90°/elbow 9 0° (2D)	Underweight	8.90±4.26	0.355
	Normal	10.84±3.50	
	Overweight	11.56±4.78	
	Obese	9.90±4.05	

P: proximal level; D: distal level

Determining the optimal position of the arm for visualising the target nerves while performing ultrasound-guided axillary brachial plexus block may improve the efficiency and safety of the procedure (3). Our results may aid in the identification of landmarks for axillary nerve block and facilitate the performance of axillary nerve block. Because these nerve blocks are usually effective for early relief, their popularisation can lead to a reduced need for post-operative analgesics (6). Hopefully, earlier rehabilitation and quick recovery can be possible because of the widespread use of axillary nerve blocks by the results we reported.

Recently, distal peripheral nerve blocks have facilitated hand and wrist surgery. Attributed to ultrasound guidance, distal nerve blocks of the upper limb have become a technically more feasible, safe and effective modality (8). Because better visualization ensures minimum tissue trauma, nerve damage and lower dose local anesthetic usage. Another advantage of distal peripheral nerve blocks is the maintenance of proximal muscle function of the upper limb. The inability to use the limb that underwent intervention notably decreases the satisfaction of the patient (8).

Ultrasound-guided selective nerve block can be accomplished by means of tracing the nerve branching from axillary brachial plexus. This method can provide safe and efficient anaesthesia at a relatively low anaesthetic dose and concentration (9).

Ultrasonography at the axillary level outlines the alignment of nerves and vessels. At this level, the nerves exist as round or oval hypoechoic structures with punctuated internal echoes (1). Axillary usage of ultrasound is a useful technique to describe the brachial plexus anatomy in the fossa. Median, ulnar and radial nerves make a totally consistent triangle-shaped design around axillary artery that can be easily recognised with US. As arterial visualization, brachial nerves and venous relation is clearly demonstrated with ultrasound guidance (10). In contrast, the musculocutaneous nerve differs from the other terminal nerves of the upper extremity and lies outside the neurovascular bundle (1). Identifying anatomical variants from expected patterns of peripheral nerve location can be challenging during a nerve block procedure. In the arm, variations of the nerves innervating the ventral compartment such as musculocutaneous and median nerves are more frequent (1). Because aberrations of the association between these two nerves are frequent and occur in up to 20% of cases, recognition and orientation of the median and musculocutaneous nerves before axillary nerve block is particularly important (11-16). To achieve the anaesthesia of the forearm completely, blocking the musculocutaneous nerve is essential. Nevertheless, variations in its course and position can interfere with the exact localisation of the nerve.

Identification of the musculocutaneous nerve for neural blockage is crucial for providing surgical anaesthesia for the distal forearm. Ultrasonography is supposed to enhance the localisation and local anaesthetic block of the musculocutaneous nerve (11).

Similar with our data, Ruíz et al. (17) reported that the depth of the brachial plexus is reduced with the abduction of the arm. Frkovic et al. (3) implied that improved visibility of nerves at abduction of the arm may be linked with the anatomical re-arrangement of the plexus or compression of tissues in various positions. We suggest that the evaluation of anatomical variations is crucial in regional anaesthesia and that failure to determine the alignment of the musculocutaneous and median nerves may both frustrate the physician and cause patient discomfort or complications. Ultrasound guidance, appropriate positioning and detailed knowledge of pertinent anatomy are key points for successful axillary block without repeated attempts. and avoidance of repeated attempts.

Ultrasonographic visibility of the median and musculocutaneous nerves was significantly affected by position of the shoulder or elbow and the probe distance from the axilla. Consequently, we attempted to outline the optimal arm and scan position for improved visibility and a more effective block. The position that provides the shortest distance between the median and musculocutaneous nerves was assumed to be the most appropriate position for axillary block.

Limitations of this study include the small sample size, data derived from the experience of a single institution and ethnic genetic factors that may interfere with interpretation of our data. Furthermore, technical limitations linked with equipment and operator must be considered.

Conclusion

We suggest that appropriate positioning of the upper limbs and good anatomical knowledge are crucial for identifying the median and musculocutaneous nerves during distal peripheral nerve block under ultrasound guidance. Our results indicated that the position in which these two nerves lie close to each other was found to be shoulder 90°/elbow 0° at the distal level. Thus, this position can be selected to achieve a safer and more effective axillary nerve block procedure.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Kafkas University School of Medicine (Decision dated 11.11.2015 no:08).

Informed Consent: Written informed consent was obtained from katılımcılardan who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - Ö.Ö.; Design - Ö.Ö., B.D.; Supervision - A.B., E.E.; Resources - Ö.Ö., H.Y.; Materials - A.B.; Data Collection and/or Processing - Ö.Ö., A.H.T.; Analysis and/or Interpretation - B.D., Ö.Ö., A.H.T., H.Y.; Literature Search - E.E., B.D., Ö.Ö.; Writing Manuscript - Ö.Ö., A.H.T.; Critical Review - B.D., A.B., H.Y.; Other - B.D., A.B., Ö.Ö.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study has received no financial support.

Etik Komite Onayı: Bu çalışma için etik komite onayı Kafkas Üniversitesi Tıp Fakültesi'nden (Karar tarihi 11.11.2015 numara:08) alınmıştır.

Hasta Onamı: Bu çalışmaya katılan katılımcılardan yazılı bilgilendirilmiş onam alındı.

Hakem Değerlendirmesi: Dış bağımsız.

Yazar Katkıları: Fikir - Ö.Ö.; Tasarım - Ö.Ö., B.D.; Denetleme - A.B., E.E.; Kaynaklar - Ö.Ö., H.Y.; Malzemeler - A.B.; Veri Toplanması ve/veya İşlemesi - Ö.Ö., A.H.T.; Analiz ve/veya Yorum - B.D., Ö.Ö., A.H.T., H.Y.; Literatür Taraması - E.E., B.D., Ö.Ö.; Yazıyı Yazan - Ö.Ö., A.H.T.; Eleştirel İnceleme - B.D., A.B., H.Y.; Diğer - B.D., A.B., Ö.Ö.

Çıkar Çatışması: Yazarlar çıkar çatışması bildirmemişlerdir.

Finansal Destek: Yazarlar bu çalışma için finansal destek almadıklarını beyan etmişlerdir.

References

1. Orebaugh SL, Pennington S. Variant location of the musculocutaneous nerve during axillary nerve block. J Clin Anesth 2006; 18: 541-4. [CrossRef]
2. Bargallo X, Carrera A, Sala-Blanch X, Santamaría G, Morro R, Llusá M, et al. Ultrasound-anatomic correlation of the peripheral nerves of the upper limb. Surg Radiol Anat 2010; 32: 305-14. [CrossRef]
3. Frkovic V, Ward C, Preckel B, Lirk P, Hollmann MVV, Stevens MF, et al. Influence of arm position on ultrasound visibility of the axillary brachial plexus. Eur J Anaesthesiol 2015; 32: 771-80. [CrossRef]
4. Hadzic A, Vloka JD, Kuroda MM, Koorn R, Birnbach DJ. The practice of peripheral nerve blocks in the United States: a national survey [p2e comments]. Reg Anesth Pain Med 1998; 23: 241-6. [CrossRef]
5. Fanelli G, Casati A, Garancini P, Torri G. Nerve stimulator and multiple injection technique for upper and lower limb blockade: failure rate, patient acceptance, and neurologic complications. Study Group on Regional Anesthesia. Anesth Analg 1999; 88: 847-52. [CrossRef]
6. Nam YS, Jeong JJ, Han SH, Park SE, Lee SM, Kwon MJ, et al. An anatomic and clinical study of the suprascapular and axillary nerve blocks for shoulder arthroscopy. J Shoulder Elbow Surg 2011; 20: 1061-8. [CrossRef]
7. Remerand F, Laulan J, Couvret C, Palud M, Baud A, Velut S, et al. Is the musculocutaneous nerve really in the coracobrachialis muscle when performing an axillary block? An ultrasound study. Anesth Analg 2010; 110: 1729-34. [CrossRef]
8. Sehmbi H, Madjdpour C, Shah UJ, Chin KJ. Ultrasound guided distal peripheral nerve block of the upper limb: A technical review. J Anaesthesiol Clin Pharmacol 2015; 31: 296-307. [CrossRef]
9. Matsuda H, Oka Y, Takatsu S, Katsube R, Yoshida R, Oyama T, et al. Ultrasound-guided block of selective branches of the brachial plexus for vascular access surgery in the forearm: a preliminary report. J Vasc Access 2016; 17: 284-90. [CrossRef]
10. Ustuner E, Yılmaz A, Özgencil E, Okten F, Turhan SC. Ultrasound anatomy of the brachial plexus nerves in the neurovascular bundle at the axilla in patients undergoing upper-extremity block anesthesia. Skeletal Radiol 2013; 42: 707-13. [CrossRef]
11. Spence BC, Sites BD, Beach ML. Ultrasound-guided musculocutaneous nerve block: a description of a novel technique. Reg Anesth Pain Med 2005; 30: 198-201. [CrossRef]
12. Loukas M, Aqueelah H. Musculocutaneous and median nerve connections within, proximal and distal to the coracobrachialis muscle. Folia Morphol (Warsz) 2005; 64: 101-8.
13. Macchi V, Tiengo C, Porzionato A, Parenti A, Stecco C, Bassetto F, et al. Musculocutaneous nerve: histotopographic study and clinical implications. Clin Anat 2007; 20: 400-6. [CrossRef]
14. Choi D, Rodríguez-Niedenführ M, Vázquez T, Parkin I, Sañudo JR. Patterns of connections between the musculocutaneous and median nerves in the axilla and arm. Clin Anat 2002; 15: 11-7. [CrossRef]
15. Beheiry EE. Anatomical variations of the median nerve distribution and communication in the arm. Folia Morphol (Warsz) 2004; 63: 313-8.
16. Budhiraja V, Rastogi R, Asthana AK, Sinha P, Krishna A, Trivedi V. Concurrent variations of median and musculocutaneous nerves and their clinical correlation--a cadaveric study. Reg Anesth Pain Med 2005; 30: 385-90.
17. Ruíz A, Sala X, Bargalló X, Hurtado P, Arguis MJ, Carrera A. The influence of arm abduction on the anatomic relations of infraclavicular brachial plexus: an ultrasound study. Anesth Analg 2009; 108: 364-6. [CrossRef]