Comparison Of Neurostimulator Use With Ultrasound-Guided Neurostimulator Use In Axillar Brachial Plexus Block: A Prospective Randomized Controlled Study[1*]

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Comparison of neurostimulator use versus ultrasound-guided neurostimulator use in axillary brachial plexus block

Objectives: Different methods may be used in application of axillar block. The aim of this study is to investigate the effect of ultrasonography on block success, complications and patient satisfaction in application of axillary brachial plexus block.

Methods: After obtaining approval from the ethics committee and consent of the patients, 50 ASA I-III patients over age of 20, planned to undergo forearm and hand surgery have been included in this study. Ekg, non-invasive blood pressure and peripheral oxygen saturation of the patients were monitored after their demographic data were recorded. Brachial plexus block was applied with only neurostimulator in Group I (n=25) and with ultrasonography guided neurostimulator in Group II (n=25). Number of skin punctures, presence of vascular punctures and processing time were recorded. Sensorial block formation was evaluated by pin-prick testing, motor block was evaluated by Holmenn scale and sensation of pain was evaluated with numerical pain rating scale. The operation began after duration of block formations was recorded. Need for general anesthesia and patient satisfaction were also recorded.

Results: Demographic data, time of onset of motor and sensorial block, operation and process time, and pain score was found to be similar in Group I and II. Number of skin punctures and vascular punctures were significantly less in Group II.

Conclusion: Block success and patient satisfaction were found to be similar in both groups but complication rate observed was significantly lower in ultrasound-guided neurostimulator group ($p<0.01$).

***Keywords*:** *Axillary block, ultrasonography, neurostimulator*

Aksiller Yaklaşımla Brakiyal Pleksus Bloğu Uygulamasında Nörostimülatör Kullanımı İle Ultrasonografi Eşliğinde Nörostimülatör Kullanımının Karşılaştırılması: Prospektif Randomize Kontrollü Çalışma

Amaç: Aksiller blok uygulamasında farklı yöntemler kullanılabilmektedir. Bu çalışmada aksiller brakiyal pleksus blokajı uygulamasında ultrasonografi kullanımının blok başarısı, komplikasyonlar ve hasta memnuniyetine etkisinin

araştırılması amaçlandı.

Metod: Etik kurul onayı ve hasta onamları alınarak, ASA I-III, 20 yaş üzeri, önkol ve el cerrahisi uygulanacak 50 hasta çalışmaya dahil edildi. Demografik verileri kaydedilen hastalarda Ekg, noninvaziv kan basıncı ve periferik oksijen saturasyonu monitörize edildi. Grup I'de (n=25) tek başına nörostimülatör kullanılarak, Grup II'de (n=25) ise ultrasonografi eşliğinde nörostimülatör kullanılarak brakiyal pleksus bloğu uygulandı. İşlem süresince kaç kez iğne girişi olduğu, vasküler ponksiyon varlığı ve işlem süresi kaydedildi. Hastada sensitif blok oluşumu pin-prick testi ile motor blok Holmenn skalası ile ve ağrı, sayısal ağrı skorlaması ile değerlendirildi. Blok oluşma süreleri kaydedilerek operasyona başlandı. Genel anestezi ihtiyacı, hasta memnuniyeti kaydedildi.

Bulgular: Demografik veriler, motor ve sensitif blok başlama süreleri, operasyon ve işlem süresi, ağrı skoru Grup I ve II'de benzer bulundu. İğne giriş sayısı ve vasküler ponksiyon Grup II'de anlamlı olarak daha düşüktü.

Sonuç: Sonuç olarak; blok başarısı ve hasta memnuniyeti her iki grupta benzer bulundu ancak komplikasyon oranı ise ultrasonografi eşliğinde nörostimülatör kullanılan grupta anlamlı olarak düşük bulundu ($p< 0.01$)

Anahtar Kelimeler: *Aksiller blok, ultrasonografi, nörostimülatör*

INTRODUCTION

In order to avoid possible complications of general anesthesia especially in high-risk patients, peripheral nerve blocks are increasingly becoming the treatment method of choice today.

Many factors including low analgesic and antiemetic consumption, duration of recovery room and hospital stay, mild transition to pain control, increase of extremity blood flow and not requiring tracheal intubation are considered to be marked supremacies of regional anesthesia compared to general anesthesia (Kwofie, Shastri & Vandepitte C, 2013).

The axillary approach is the most easily applied and commonly used technique in brachial plexus block. It has a lower risk of complication than the other methods due to the distance of puncture location from vital structures and is commonly used for forearm and hand operations (Satapathy & Coventry, 2011).

Main requirement for a successful peripheral block is proper distribution of local

anesthetics around nerve structures (Denny NM & Harrop-Griffits W, 2005). To this day, methods used in nerve localization are paresthesia, transarterial method, loss of resistance method, peripheral nerve stimulator and ultrasonography (US).

A specific alarm threshold needs to be applied to a nerve in order to generate alarm. This condition sets the base of nerve stimulation (Hogan, 2003). Peripheral nerve stimulation is a valuable adjuvant in clinical application and its combination with atraumatic catheter provides an important advantage. However, needle-nerve relation and the region where the local anesthetic is dispersed which was applied via needle is unknown in these methods.

The distance of needle from the nerve and the amount of local anesthetic spread over the nerve can be monitored simultaneously when US is used (Kuş et al.,2010; Fuzier et al.,2006; Dingemans et al., 2007) Therefore, amount of applied local anesthetic and possible block complications may be decreased (Dingemans et al., 2007; Loubert et al., 2008)

Another advantage of block application under US surveillance is that it can be applied with safety where blocks via nerve stimulation are impracticable. These conditions include obesity, symptom of an illness with systemic neuropathy at the extremity, cases where anatomical reference points cannot be determined, nonresponse of distal motor in block application area due to a past surgery or trauma, nerve incision at the extremity where block will be applied or application of muscle relaxant under general anesthesia (Gürkan et al., 2009)

The aim of this study is to compare block success, complications and effects on patient satisfaction of neurostimulator or US-guided neurostimulator in axillary brachial plexus block (ABPB).

Material and Methods

After the approval of the ethics committee (2012/08/02 on 21.05.2012) and written consent from patients were obtained, 50 ASA I-III patients over the age of 20 were included in our study for elective forearm and hand surgery, in Okmeydani Teaching and Research Hospital in Istanbul. The study was planned as two groups, “Group I” consisted of cases where only neurostimulator (NS) was used for the application of ABPB, whereas “Group II” cases had both NS and US used for the block application.

Patients who did not want regional anesthesia, pregnant women, ones who had

infection in the entry region, anticoagulant users, patients with a history of neuropsychiatric disease or a history of allergic reaction to the medications were not included.

Patients were taken to the regional anesthesia section inside the operating room. Arterial blood pressure (systolic, diastolic and mean arterial blood pressure), heart rate (HR) and peripheral oxygen saturation (SpO_2) were monitored. Demographic data of the patients was recorded.

After establishing vascular access from back of the hand that would not be operated, with intravenous cannula (20 Gauge), 70ml/h isotonic sodium chloride solution was administered to the patients. All patients had an application of 0.03 mg kg^{-1} intravenous midazolam and laid down in supine position.

Hand waiting for block application was positioned in abduction, forearm in 90 degrees flection with the palm looking upwards. One EKG electrode was attached to the inner wrist of the same hand. Povidone-iodine was used to clean the skin of the block area and 2ml of 2% lidocaine was used for local anesthesia.

Multistimupleks® (Pajunk, Germany) was used as the nerve stimulator and the needle was 21 Gauge, 50mm Stimupleks A® (B. Braun, Melsungen AG, Japan), specifically made for plexus anesthesia. The cathode pole of the nerve stimulator was connected to conductive end of the needle and anode pole was connected to the EKG electrode on the inner wrist. Initially, stimulator was set with parameters of 1.0 mA, 2 Hz, 0.1mS.

In Group I; entry point was established by palping axillar artery and after the needle was injected perpendicularly to the skin, twitch movements of the muscles innervated by the nerves that form the brachial plexus (n. medianus, n. ulnaris, n. radialis, n. musculocutaneus) were looked for.

Once twitch response from the nerves was received, it was decreased to 0,4 mA and continuation of nervous twitch was considered to be an indication of successful localization. In case the twitch continued at 0.4mA, after the initial aspiration test, a total of 10 ml local anesthetic solution was administered while repeating the aspiration at each 5 ml interval. A total of 40 ml local anesthetic solution (2% prilocaine HCl 10 ml+ 0,5% bupivacaine HCl 14 ml + 0,9% NaCl 16 ml) was given to wrap around axillar artery.

In Group II; after covering US (Ultrasonix Sonix Tablet®) probe with a sterile cover, lubricant sterile gel (Cathejell®, Taymed Sağlık Ürünleri Tic. Ltd. Şti.)was

applied on the skin to display median, ulnar and radial nerves in and around axillar artery and musculocutaneus nerve inside coracobrachialis muscle. When needle was observed in close proximity with the nerves under US imaging after cutaneous and subcutaneous in-plane technique was applied, stimulator was opened to look for twitch movements at the muscles. Once twitch response was received, following the aspiration test, 10ml of local anesthetic solution was administered for each nerve. In cases where twitch could not be observed, a total of 40ml local anesthetic solution (2% prilocaine HCl 10 ml+ 0,5% bupivacaine HCl 14 ml + 0,9% NaCl 16 ml) was given to wrap around axillar artery.

Once it was applied, sensorial block was evaluated with pin-prick test and quality of motor block was evaluated with Holmenn scala (Table 1).

Table 1: Evaluation of sensorial and motor block

Sensorial Block	
0	Normal transmission with pin-prick
1	Feeling the needle less compared to the other extremity
2	Sensing the needle like an blunt matter
3	Loss of sense of touch
Motor block quality (Holmenn scala)	
0	Normal muscle function
1	Decreased muscle function than before (block)
2	Very decreased muscle function
3	Complete motor block

Processing time, number of skin punctures and presence of vascular puncture was recorded. Neural puncture presence, paresthesia, and patient's sudden intense pain descriptions during the process were evaluated. Patient's pain during the pre-operation process was recorded after inquiring with numerical pain rating scale. If general anesthesia was needed to be taken to operation, it was also recorded. At the end of the operation, operation time and patients satisfaction from the anesthetic method applied was inquired and noted.

Software used for statistical analysis was NCSS (Number Cruncher Statistical System) 2007&PASS (Power Analysis and Sample SizeSt) 2008 Statistical Software(Utah, USA) program. Along with descriptive statistical methods (mean, standard deviation, median, frequency, ratio), comparison of parameters with normal distribution between groups was performed with Student t test; comparison of parameters without normal distribution was conducted using Mann Whitney U test while study data was evaluated. Chi-Square test, Yates Chi-Square test and Fisher's Exact test was used for comparison of qualitative data. Evaluated significance was $p<0.05$.

Results

Of 50 cases included in the study, 58% (n=29) were male and 42% (n=21) were female.

The ages of the cases varied between 20-77, and the age average was calculated as 45.24±15.38. Average age difference between study groups was not statistically significant. The average age of Group I was 48.56±15.54; of Group II was 41.92±14.78 (Table2).

Table 2. Evaluation of demographic data

		Group 1 (n=25)	Group 2 (n=25)	*p*
		Mean±SD	Mean±SD	
Age (years)		48,56±15,54	41,92±14,78	*0,128*
Weight (kg)		78,40±8,66	74,96±15,48	*0,337*
Size (cm)		167,48±6,93	167,20±8,51	*0,899*
BMI (kg/cm^2)		28,01±3,35	26,80±5,47	*0,352*
		n(%)	n(%)	
[a]Gender	Female	14 (%56,0)	15 (%60,0)	*1,000*
	Male	11 (%44,0)	10 (%40,0)	

Student t Test [a]*Yates Test*

Between demographic data of study groups such as gender, body weight, height and BMI, the difference was not statistically significant (p>0.05) (Table2). Operation times were found to be similar for both groups.

Comparison of block application periods between groups did not produce any statistically significant difference. The average operation time for Group I was 8.12±2.01; for Group II it was 8.36±1.71 (Table3).

Table 3. Evaluation of process time with regards to groups

	Process Time (min)		*p*
	Mean	SD	
Group 1 (n=25)	8,12	2,01	*0,651*
Group 2 (n=25)	8,36	1,71	

Student t Test

Difference of motor and sensorial block formation periods between groups were not statistically significant (Table 4).

Table 4: Evaluation of motor block, sensorial block and operation time with regards to groups

	Group 1 (n=25)	**Group 2 (n=25)**	**p**
	Mean±SD	**Mean±SD**	
Motor Block Time (min)	20,36±3,47	19,40±3,30	**0,322**
Sensorial Block Time (min)	12,44±2,33	12,04±2,19	**0,534**
[a] **Operation Time (min)**	62,40±37,14	53,80±25,18	**0,490**

Student t Test [a]*Mann Whitney U Test*

The difference of average numerical pain scores between groups was not considered statistically significant.

The average pain score of Group I was 3.52±1.47; of Group II was 2.92±1.15 (Table 5).

Table 5: Evaluation f groups with regards to pain score and general anesthesia need

		Group 1 (n=25)	Group 2 (n=25)	*P*
		Mean±SD	**Mean±SD**	
Pain Score		3,52±1,47	2,92±1,15	***0,116***
		n(%)	**n(%)**	
[a]**General Anesthesia Need**	**Yes**	23 (%92,0)	25 (%100,0)	***0,490***
	No	2 (%8,0)	0 (%0,0)	

Student t Test [a]*Fisher's Exact Test*

Only 2 cases required general anesthesia, both of them were from Group I. But there was no statistically significant difference (Table 5).

The difference between injection numbers of cases according to their study groups was statistically significant ($p<0.01$). Number of skin punctures was significantly higher on Group I. Within Group I, 8% of cases had one injection, 48% had two injections and 44% had three and more injections; within Group II, 60% had one injection, 36% had two injections and 4% had three and more injections (Table 6)

The vascular puncture observance rate between study groups was statistically significant on a high level ($p<0.01$). Cases from the first group had a significantly higher vascular puncture rate (Table 7). The neural puncture was not observed in any of the cases (Table 7).

The difference of patient satisfaction levels of cases according to their study groups was not considered to be statistically significant. Three cases from Group I were not satisfied. The satisfaction rate of Group I was 88%; the satisfaction rate of Group II: 100% (Table 8)

Table 6: Comparison of the groups for number of skin punctures

	Group 1 (n=25)	**Group 2 (n=25)**	
	Mean±SD (median)	**Mean±SD (median)**	***P***
Number of Skin Punctures	2,52±1,01 (2)	1,48±0,71 (1)	***0,001****
	n (%)	**n (%)**	***+p***
1 times	2 (%8,0)	15 (%60,0)	
2 times	12 (%48,0)	9 (%36,0)	***0,001****
3 times and over	11 (%44,0)	1 (%4,0)	

Mann Whitney U test +Chi-Square test **p<0,01

Table 7: Evaluation of neural and vascular punctures with regards to groups

		Group 1 (n=25)	**Group 2 (n=25)**	**p**
		n(%)	**n(%)**	
Neural Punctures	**Yes**	25 (%100,0)	25 (%100,0)	**-**
	No	-	-	
Vascular Punctures	**Yes**	10 (%40,0)	23 (%92,0)	**0,001****
	No	15 (%60,0)	2 (%8,0)	

Yates Test **p<0,01

Table 8: Evaluation of patient satisfaction level with regards to groups

		Group 1 (n=25)	**Group 2 (n=25)**	
		n(%)	**n(%)**	
Patient Satisfaction	**Yes**	**22 (%88,0)**	**25 (%100,0)**	**0,235**
	No	**3 (%12,0)**	**0 (%0,0)**	

Fisher's Exact Test

DISCUSSION

Peripheral nerve block is a frequently preferred technique in upper extremity surgery due to its various advantages.

Key to a successful peripheral nerve block is to ensure adequate distribution of local anesthetic around the nerve.

Gili et al. (Gili et al., 2019) pointed out in their study that there are different variations in nerve locations around the brachial artery. Therefore, this can be achieved most efficiently by sonographic imaging. Anesthetists are able to see the nerve and surrounding structures (veins, muscle, etc.) directly with high-resolution ultrasonographic imaging and it increases the quality of nerve blockage while decreasing complications (Hopkins, 2007).

Khabiriet.al. (Khabiri, Arbona & Norton, 2010) made an ultrasonographic examination after observing a problem on an infraclavicular block applied to a patient in whom an anatomic variation was detected. Thereby it was reported that US use in regional anesthesia would provide an additional safety measure and might decrease complications. Studies which show less side effects seen in US-guided block underlines the advantage of this technique (Liu et al., 2005; Danelli et al., 2012; Conceição, Helayel & OliveiraFilho, 2009; Morros et al., 2009).

In our study, there were no clinical findings of intravascular injection, diaphragm paralysis and pneumothorax suspicion in any patient.

There are different studies comparing US and NS use in ABPB that find the block application time similar and US use increases the block application time (Conceição, Helayel & OliveiraFilho, 2009; Morros et al., 2009).

Morros et.al. (Morros et al., 2009) found out that US use increased the quality of block in the study where they examined the addition of US guidance to NS use in ABPB.

Lo et. al. (Lo et al., 2008) retrospectively evaluated 662 cases and compared traditional nerve localization techniques with US usage and found out that block success increased where amount of local anesthetic and block application time decreased in US-guided axillary brachial block applied group.

In a study conducted by Marhofer& Co. (Marhofer et al, 2004) argued sensorial and motor block response was quicker and sensorial block period was longer in US-guided infraclavicular brachial plexus block on children as opposed to block made

with nerve stimulator.

After conducting a study comparing US and NS use in application of axillary brachial plexus, Zencirci found out that US-guided group was more successful due to faster block initiation time and better motor block quality (Zencirci, 2011).

Strubet.al.(Strub et. al., 2011) study where they researched the benefits of US usage in application of axillary brachial plexus block found out that block success was higher and block formation time was lower in the US group; complications and operation time difference was not significant.

US-guidance in application of axillary brachial plexus is reported to lower the ratio of vascular punctures (Conceição, Helayel & OliveiraFilho, 2009; Morros et al., 2009). In our study, the US group's number of vascular puncture is lower, also.

In a study where Bloc et.al. (Bloc et al., 2010) evaluated patient comfort in application of ABPB with the US and neurostimulator use, found US group to be less painful and block application on US group more comfortable.

Kumar et. al.(Kumar et al.,2014) did not find a difference between sensorial and motor block initiation time and patient satisfaction in their study of axillary block application with NS and US guidance. But they found the median number of skin punctures less in US group and the US group also required fewer needle redirections.

In our study, when patient satisfaction was inquired, all 3 of the dissatisfied patients were in only neurostimular used group, though the difference was not statistically significant. The number of skin punctures was significantly lower in the US group.

In conclusion, axillary brachial plexus blockage applied with NS use under US-guidance is superior as it causes less complication.

AUTHOR CONTRIBUTION

Esengül KELEŞ: Idea / Notion, Data Collection and / or Processing, Literature Review, Writing the Article

Ülkü Aygen TÜRKMEN: Idea / Notion, Literature Review, Writing the Article

Döndü Genç MORALAR: Idea / Notion, Analysis and / or Interpretation, Literature Review, Critical Review

Zekeriya ERVATAN: Design, Data Collection and / or Processing, Analysis and /or Interpretation, Literature Review, Critical Review

Erdinç DENİZLİ: Design, Data Collection and / or Processing, Literature Review

Mensure ÇAKIRGÖZ: Analysis and /or Interpretation, Literature Review, Critical Review

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