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Basic Study

Brachial artery sympathetic innervation

The contribution of the median and ulnar nerve to the sympathetic innervation of the brachial artery

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Abstract

BACKGROUND

The sympathetic nervous system makes medium and large peripheral arteries smaller and slows the flow of blood through them.

AIM

Brachial arteries sympathetic innervation

METHODS

Based on this knowledge, we developed a neurophysiological autonomous test that measures the effects of peripheral sympathetic fibers on peripheral arteries. Our specific objective is to find out the sympathetic innervation of the brachial artery. For this purpose, right arms Brachial artery baseline diameter and flow rate have been measured. Then, for 5 s, electrical stimulus was applied to the medial nerve. As it's supposed to be, by electrical sympathetic activation, the vessel diameter and overall flow rate will decrease. After seven days, a similar experiment was repeated using the ulnar nerve.

RESULTS

The differences in the diameter and flow rate of the brachial artery in response to median and ulnar nerve activation were compared. In the total group, no significant difference in diameter change was seen between medial and ulnar nerve stimulation ($P = 0.648$). The difference in absolute slowdown of flow rate between stimulation of the median nerve and stimulation of the ulnar nerve was not statistically significant in the entire group ($P = 0.733$).

CONCLUSION

As a target organ, the brachial artery receives an equal amount of sympathetic innervation from the median and ulnar nerves.

Key Words: Median Nerve; Ulnar Nerve; Brachial Artery; Sympathetic Nervous System; Functional Anatomy

Ege F, KAZCI Ö. BRACHIAL ARTERY SYMPATHETIC INNERVATION. *World J Neurol* 2022; In press

Core Tip: These observations imply that a peripheral nerve injury causes vasomotor paralyses and higher blood flow in large and medium arteries of extremities; and that conversely physiological activation of a peripheral nerve causes lower blood flow. Our study depends on this pathophysiological background and aims to investigate the anatomical innervation of brachial artery by utilizing a neuro-physiological experiment. As a target organ, the Brachial artery receives equal amount of sympathetic innervation from the Median and Ulnar nerves. Expanding similar neurophysiological research to other arteries in the upper and lower limbs will contribute to the field of functional neuroanatomy's advancement.

INTRODUCTION

The sympathetic nervous system is primarily responsible for controlling the peripheral arteries[1]. However, there is currently insufficient information to determine which artery receives more postganglionic sympathetic innervation from which peripheral nerve. As we know, there are two post-mortem reports comparing the sympathetic fiber intensity of the median and ulnar nerves. The first one of these is the dark fluid fluorescence microscopic study of Morgan *et al*, and according to them, the median nerve's sympathetic fiber density is higher than that of the ulnar nerve, particularly at the elbow level[2]. Another one is the immunohistochemistry-assisted investigation of Balogh *et al*, and their findings indicate that there is no substantial variation in sympathetic fiber distribution between the median and ulnar nerves (3). While these two studies examined the density of sympathetic fibers of median and ulnar nerves, they can't make a claim on the effects of these fibers on target organs because such evidence, for instance, a specific proof intended for postganglionic innervation of the brachial artery, can only be demonstrated through functional autonomic tests.

The data presented here are composed of a subgroup of a larger unpublished and ongoing study in which we assess the brachial artery's sensitivity to sympathetic nervous system activity. As is well known, the sympathetic nervous system has the effect of narrowing the diameter of medium and large peripheral arteries and decreasing their blood flow (4). Based on this knowledge, we developed a model analogous to the sympathetic skin response (SSR), in which the sympathetic sudomotor response is assessed *via* electrical stimulation of a peripheral nerve (5). However, unlike SSR, this study assessed not the sudomotor but the vasomotor response by utilizing focal electrical stimulation of a peripheral nerve and doppler USG.

With the aid of a neurophysiological autonomous test, our primary objective is to determine through which peripheral nerve the brachial artery receives more intense sympathetic innervation.

MATERIALS AND METHODS

Subjects: The studies conformed to the current version of the Declaration of Helsinki, and the protocols were authorized by the Clinical Research Ethics Committee at Ankara City Hospital No. 2. The study meets the guidelines that are described in "Preliminary Minimum Reporting Requirements for In-Vivo Neural Interface Research: I. Implantable Neural Interfaces" (6).

Subjects with polyneuropathy, median or ulnar neuropathy, peripheral artery disease, diabetes mellitus, essential hypertension, and cardiac disease are excluded. Individuals experiencing numbness, paraesthesia, or discomfort in their hands were checked for a peripheral nerve injury 24 h prior to the test using a nerve conduction study in the electrophysiology laboratory, and subjects with abnormal values were also excluded. All of the people who took part in the study signed a form saying they understood what was going on and gave their permission.

Experimental Design: Nicotine, caffeine, alcohol, and exercise are restricted 6 h before the test. The study was conducted at a room temperature of 22–24 degrees Celsius. For 5 minutes, participants rested in a seated position with their forearms supinated. And then blood pressure, heart rate, and body temperature were measured and subjects who had abnormal values were again excluded at this stage. This was one male subject with high blood pressure (> 135/85 mmHg). A radiologist with six years of expertise in the field of doppler imaging, measured the right brachial artery baseline diameter and flow rate from 2 cm superior to the antecubital fossa using a 9Hz linear probe of General Electric (GE) LOQIC P2 USG Doppler equipment (Figure 1). The probe's position was not changed, and the image was continually obtained. Then, for 5 s, 1 Hz electrical stimulus with an intensity of 10mA was applied to the median nerve at the wrist level in the direction of sensory fibers (orthodromic way) using the bipolar stimulus electrode of the Nihon Kohden MEB-9400A EMG/EP system (Figure 2). At the fifth second of electrical current, the diameter and flow rate of the brachial artery were measured once again. As it's supposed to be, by electrical sympathetic activation, the vessel diameter and overall flow rate will decrease. We recorded the baseline and post-stimulus data from the brachial artery. After seven days, baseline diameter and flow rate measurements were repeated from the right arm, and the same intensity of electrical current was supplied from the Ulnar nerve this time (Figure 3). In the fifth second, images from the brachial artery were recorded once more. The differences in the diameter and flow rate of the brachial artery in response to median and ulnar nerve activation were compared.

Statistical Analyses: Descriptive analyses were presented using frequency distributions for the categorical variable age and using medians (min-max) for numerical variables. The Mann-Whitney U test was used to compare numerical variables between independent groups. For two dependent groups, numerical comparisons were made using the Wilcoxon test.

A p-value of less than 0.05 was considered to show a statistically significant result. Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) for Windows software version 20.0. Armonk, NY

RESULTS

Women make up 46.7% of participants. All participants were between the ages of 20 and 51 years old, with a median age of 29 years. Both sexes had a median age of 29 years.

The median flow rate of the brachial artery before the median nerve stimulus in the entire group was 79.80 (32.90–201.10) ml/min, while the post-stimulus flow rate was 44.00 (10.90–103.00) ml/min. This flow rate reduction is statistically significant (P = 0.001) (Table 1). The absolute decrease in the flow rate following the stimulus was 39.40 (19.90–124.50) ml/min on average. When the flow rate before the stimulus was compared to the flow rate after the stimulus, a median drop in the flow of 50.25 percent (28.97-71.84) was recorded.

In the entire group, the median diameter of the brachial artery before medial nerve stimulation was 0.35 (0.26-0.50) cm, while the post-stimulus diameter was 0.31 (0.16-0.45) cm. The difference in diameters prior to and following the stimulus was determined to be statistically significant (P = 0.001) (Table 2). With stimulation, the absolute change in diameter was 0.05 (0.01-0.14) cm, and the percentage change in comparison to the original diameter was 14.63 (2.86-4.67).

In the entire group, the median flow rate of the brachial artery before the ulnar nerve stimulus was 56.40 (28.10-214.00) ml/min and reduced to 30.00 (15.00-78.00) ml/min following stimulation. The difference between the two is statistically significant (P = 0.001) (Table 3). After ulnar nerve stimulation, the absolute decrease in flow rate was determined to be median at 25.10 (7.90-170.10) ml/min, while the percentage decrease was median at 48.08 (20.84-79.67).

The median diameter of the artery prior to ulnar nerve stimulation was 0.36 (0.23-0.50) cm, while the median diameter following the stimulus was 0.28 (0.19-0.48) cm. The difference in diameters prior to and following the stimulus was determined to be statistically significant (*P* = 0.001) (Table 4). With stimulation, the median absolute decrease in diameter was 0.04 (0.00-0.14) cm, and the median percentage decrease in diameter relative to the initial diameter was 17.14 (0.00-38.89) for the total cohort. Table 4 shows the diameter of the brachial artery (cm) before and after ulnar nerve stimulation in the entire group.

The difference in absolute slowdown of flow rate between stimulation of the median nerve and stimulation of the ulnar nerve was not statistically significant in the entire group (*P* = 0.733). There were no statistically significant variations observed when the same assessment was stratified by gender. Men and women were found to have *P* = 0.237 and 0.327, respectively (Table 5).

In the total group, no significant difference in diameter change was seen between medial and ulnar nerve stimulation (*P* = 0.648). There was no significant difference in diameter change between medial and ulnar nerve stimulation in either sexes (p 0.610, *P* = 0.833 for men and women, respectively) (Table 6).

DISCUSSION

It is well established that sympathetic fibers in the median nerve exert control on the flow parameters of the arteries of the upper extremities. For example, Badal *et al* discovered that medial nerve blockage increases radial artery peak velocity (7). According to Galea *et al*, triggering sympathetic activation induced by coughing followed by deep inspiration, the pulsatile index (PI) of the Radialis Indicis (RI) artery did not significantly increase in patients with carpal tunnel syndrome when compared to healthy controls (8). In a similar way, Ghasemi-Esfe *et al* showed that people with carpal tunnel syndrome have a PI value for the RI artery that is much lower (9).

These observations imply that a peripheral nerve injury causes vasomotor paralysis and higher blood flow in large and medium arteries of the extremities; and that, conversely, physiological activation of a peripheral nerve causes lower blood flow. Our study depends on this pathophysiological background and aims to investigate the anatomical innervation of the brachial artery by utilizing a neuro-physiological experiment.

A study based on invasive approaches but scientifically similar to our work has been reported by Compero *et al*, and according to their findings, while the blockage of median and ulnar nerves resulted in cutaneous vasodilatation at the respective innervation areas, a similar result has not been observed by radial nerve blockage (10). On the other hand, apart from being non-invasive, the approach we developed generates local sympathetic discharge through peripheral nerve stimulation, allowing for rapid, practical, and reproducible measurement of vasomotor responses. Owing to this advantage, comparative investigations in neurophysiology and functional anatomy have become easier. Our findings indicate that stimulation of both the Median and Ulnar nerves produces identical changes in the diameter and flow rate of the Brachial artery and that the Median and Ulnar nerves exert equal control over the Brachial artery. These findings corroborate the assumption that the brachial artery is equally innervated by the median and ulnar nerves.

Our results also suggest that, unlike muscles and sensorial skin areas, the vasomotor control of some large arteries is supplied by not a single but several peripheral nerves. However, when small arteries are taken into account, target organs are separated once again. This assumption is supported by two reports which demonstrate that the medial nerve is the single supplier of the vasomotor control of the medial and radial hand areas; the ulnar nerve is the single supplier of the ulnar hand area; and that the radial nerve does not have a meaningful impact on arterial sympathetic control of the hand (10, 11). But until today, research in this field is limited and further neurophysiological or interventional studies are needed to determine the detailed neural-vascular liaisons of the extremities.

CONCLUSION

As a target organ, the brachial artery receives an equal amount of sympathetic innervation from the median and ulnar nerves. Expanding similar neurophysiological research to other arteries in the upper and lower limbs will contribute to the advancement of the field of functional neuroanatomy.

ARTICLE HIGHLIGHTS

Research background

Determine the role of the ulnar and median nerves in the sympathetic activation of the brachial artery.

Research motivation

attempting a new autonomic neuropathy treatment

Research objectives

to determine if the ulnar and median nerves contribute equally to sympathetic stimulation of the brachial artery.

Research methods

emg observation of doppler parameters

Research results

Doppler parameters before and after stimulation of the ulnar and median nerves

Research conclusions

The brachial artery serves as a target organ and is equally innervated by the median and ulnar nerves.

Research perspectives

a new evaluation method evaluation method a new evaluation method

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