Correlation Between Nerve Diameter And Martin-Gruber Anastomosis In The Forearm In Bosnian Population: A Cadaveric Study

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***Abstract*—Backround: The Martin-Gruber anastomosis (MGA) is well known nerve communication between the median (MN) and ulnar nerves (UN) that may occur in the forearm. Our study aimed to determinate the diameter of MN and UN in the forearms regarding the presence of MGA.**

Methods: Sixty anterior forearms of fresh frozen Bosnian adult cadavers were included in the study. The NM, NU and their branches were measured in all cadavers, regardless of the existence of the anastomosis, as well as the diameter of the anastomosis, if any.

Results: The presence of MGA was verified in 11 (18.33%) forearms which were studied. The average diameter of the NM in the right forearms without the MGA was 4.09±0.34mm and in the left 4.09±0.29mm, while the diameter of NU in forearms without MGA was 3.87±0.32mm on the right and 3.85±0.27mm on the left side. The correlation coefficient between the existence of MGA and the diameter of NU was statistically significant on the both side (p≤0.0001 right; p=0.003 left).

Conclusion: A significant positive correlation was found between the diameter of NU and the presence of MGA.

Keywords—Martin-Gruber Anastomosis, nervus medianus, nervus ulnaris

Introduction

The Martin-Gruber anastomosis (MGA) is the anastomosis in which the anastomotic branch originates proximally from the median nerve (MN) and unites distally with the ulnar nerve (UN). This is the most common form of "anomalous" innervation that have been reported in the upper part of the forearm. The MGA was first described by Martin in 1763 (1). First, he described a branch between the MN and UN that sometimes runs under the pronator teres muscle, and also a connection between MN and UN in the palm which he called the "arcus volaris nervorum". In 1870, Gruber dissected 212 forearms and found in 38 forearms that nerve branches coursed from the MN proximally to the to the UN distally (2). MGA has been reported to occur in 15-31% of subjects (3, 4).

The purpose of our research was to determine the diameter of MN and UN in the forearms regarding presence of MGA. We also compared our results to those of similar previous studies.

Material and methods

Sixty anterior forearms of fresh frozen Bosnian adult cadavers were dissected in the Department for pathology of University Clinical Centre Tuzla and the morgue of Tuzla during a time period of two years. The forearms with traumatic lession that unables dissection are not included in the study. The forearm is placed in the position of supine. An 'S' shaped incision from the lower limit od cubital fossa to the radiocarpal joint was carried out. This type of incision covered the whole anterior surface of the forearm. The superficial fascia was opened and the flexor carpi ulnaris muscle and tendon mobilised to give full exposure of the ulnar artery and UN. The branches of the UN in the forearm were dissected and all possible anastomoses between MN and UN were documented. The NM, NU and their branches were carefully dissected with the aid of magnifying glasses. After that, the diameter of NM and NU were measured in all cadavers, regardless of the existence of the anastomosis, as well as the diameter of the anastomosis, if any. Diameters were measured in two places and the average value of measured diameter was taken. Point 1, where the diameter of NM and NU was measured, was 6 cm away from the lateral epicondyle of the humerus, while point 2 was 6 cm away from the middle of the radiocarpal joint. The same two independent observers measured the nerves of each cadaver. We used the mean measurement of both observers as the measurement for the nerve. The nerve diameter was measured using a digital caliper Aesculap AA845R, and measurements were taken to the nearest 0.1 mm (Figure 1). Before data collection, both observers practiced measuring on the same cadaver to establish a standardized measuring technique, which focused on measuring nerve diameter without compressing the nerve. All anatomical parts were photographed in order to register the anatomical arrangement and the relation with adjacent structures. Statistical comparisons were performed using the chi-squared test. P < 0.05 was regarded as statistically significant.

Results

Out of sixty forearms (30 left and 30 right), 46 belonged to males and 14 to females. The age of cadavers ranged from 22 to 73 years (Figure 2). The lenght of cadavers ranged from 162 to 185 centimeters while the lenght of dissected forearms measured from cubital fossa to radiocarpal joint ranged from 24.5 to 27 centimeters. The presence of MGA was verified in 11 (18.33%) forearms which were studied.

The average diameter of the NM in the right forearm was 4.15±0.41mm, and in left was 4.11±0.33mm. The average of the NU in the right forearms was 4.18±0.67mm, compared to 3.97±0.43mm in the left (Table 1).

The average diameter of the NM in the right forearms with the MGA was 4.35±0.33mm and in the left 4.22±0.56mm, while the diameter of NU in forearms with MGA was 5.18±0.55mm on the right and 4.56±0.65mm on the left side.

The average diameter of the NM in the right forearms without the MGA was 4.09±0.34mm and in the left 4.09±0.29mm, while the diameter of NU in forearms without MGA was 3.87±0.32mm on the right and 3.85±0.27mm on the left side (Table 2). The correlation coefficient between the existence of MGA and the diameter of NU was statistically significant on the both side (p≤0.0001 right; p=0.003 left).

Discussion

Anastomoses between MN and UN occur frequently in humans so therefore they are considered aa a variation rather than an anomaly. In the forearms of 15% to 31% of individuals, motor axons descend from the MN, crossing to the UN, and ultimately innervating intrinsic hand muscles which are normally supplied by the UN [3, 4]. It is generally known that the function of the peripheral nervous system is to transmit nerve impulses "in" and "from" the central nervous system. A normal axon conducts impulses at a speed of 35-60 m/sec (5). Individual axons are of different sizes, from 1 to 20 micrometers in diameter. The speed of nerve conduction velocity is proportional to the second root of the fiber thickness (6). Peripheral nerves are bundles of nerve fibers that can be of different diameters. Sporadic measurements of nerve size date back to Valentin (1836), Emmert (1836) and Rosenthaler (1845) (7). Some of the nerves are very small (less than 0.04 cm in diameter) and some are quite large (larger than 0.6 cm in diameter). Due to its size, a peripheral nerve such as the NM with a diameter of about 5 mm is responsible for performing all functions of the arm and forearm. The dimensions of NM and NU that can be measured by ultrasound, and which give adequate insight into the morphology are circumference, shorter and longer diameter and the cross-sectional area. Visualization of peripheral nerves by ultrasound depends on the diameter of the nerve and its path or accessibility. Ultrasound measured the thickness of NM in 25 healthy subjects and 50 forearms (8). The diameter of the NM by ultrasound was measured automatically using a caliper which is an integral part of the ultrasonic machine. The average NM diameter was 4.04 mm (ranging from 2.16 to 6.08 mm) (8) while the diameter of the NU is smaller compared to the NM and ranges from 2.6 mm to 4.5 mm, averaging 3.5 mm (9,10). It is known in the literature that NM is a phylogenetically older nerve and as such is thicker than NU. In our study, the average diameter of NM in the forearms without MGA was 4.09 mm, while the same diameter in the forearms with MGA was 4.33 mm for right and 4.22 mm for the left forearm. The average diameter of NU in the forearms with MGA was significantly higher compared to the diameter of NU in the forearms without MGA. The speed of motor conduction velocity depends on the thickness of the nerves or the number of motor fibers. In cases of nerve damage, the speed of motor conduction velocity is also reduced. In a study Hodžić et al (2011), the motor conduction velocity in NM and NU in subjects with and without MGA was examined (11). The results of this study showed a statistically significant difference in the speed of motor conduction velocity through NU regarding MGA. The greater diameter of NU in forearms with MGA compared to the diameter of NU in forearms without MGA can be explained by the fact that the transition of nerve fibers from NM through anastomosis and attachment to NU increases the number of NU fibers. As the number of fibers increases, so does the thickness of the nerve, which was also macroscopically noticeable during dissections. NU in forearms with verified MGA was macroscopic and thicker and harder than NU in forearms without MGA. As the thickness of the NU increases, so does the speed of motor conduction in the nerve.

This study provides reference values for nerve diameters of the forearms and describes their relative differences in forearms with and without MGA. It is important for surgeons to be aware of these differences during the operative treatments and to consider this information to avoid iatrogenic nerve injuries.

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