

# Electrophysiological Evaluation of the Incidence of Martin-Gruber Anastomosis in Healthy Bosnian Population

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## Abstract

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**Background:** Martin-Gruber anastomosis (MGA) is the well known anastomosis that occur at the various levels between the median and ulnar nerves. This anastomosis involves axons leaving either the main trunk of median nerve or the anterior interosseous nerve, crossing through the forearm to join the ulnar nerve. Knowledge of the incidence of this anastomosis is necessary because MGA can cause confusion in the assessment of nerve injuries and compressive neuropathies.

**Aim:** We aimed to assess the occurrence and motor velocities of median to ulnar nerve communication (MGA) in the forearm of Bosnian population by electrophysiological examinations.

**Material and Methods:** One hundred and twenty forearms from a series of 60 volunteers (25 females, 35 males, 23-78 years of age) were studied electrophysiologically using needle recording electrodes. Volunteers with peripheral neuropathies were excluded from the study. Needle recording electrodes were placed on the thenar and hypothenar muscles. The median and ulnar nerves were stimulated supramaximally at the wrist and the elbow and compound muscle action potentials (CMAPs) were recorded as well as motor conduction velocities of median and ulnar nerves.

**Results:** Martin-Gruber anastomosis was found in 27 of 120 forearms; it was bilateral in 7 and unilateral in 13, on the right side in nine and on the left side in four forearms. There were no significant sexual differences in the incidence. In MGA, when stimulating median nerve the response of abductor digiti minimi was registered in 11, whereas the response of opponens pollicis when stimulating ulnar nerve was registered in 18 subjects. This finding was statistically significant.

**Conclusion:** With high incidence of MGA in Bosnian population, it is necessary to be aware of the existence of this anomaly, location and its possible presentation.

## Introduction

The Martin-Gruber anastomosis (MGA) is the most well known anastomosis that occur between median and ulnar nerves. It is formed by motor axons from the median nerve or its branch anterior interosseous nerve that cross in the upper forearm to join the ulnar nerve [1]. This anastomosis was the first time described by the Swedish anatomist Martin in 1763 and later by Gruber in 1870 [2]. Such a communication, occurs in 15-75% of

subjects in unselected population and can be unilateral or bilateral. MGAs have been reported to be bilateral between 10% to 40% of cases [3]. When present, unilateral MGAs occur more often in the right arm than the left [4]. Some reports have suggested a relationship between genetic factors and the presence of MGA. Srinivasan and Rhodes examined congenitally abnormal fetuses and found that all fetuses with trisomy 21 had an MGA in both forearms. These findings suggested an

autosomal dominant inheritance [5]. It appears that MGAs carry only motor fibres.

In the study performed on 200 upper limbs from 100 human fetuses, the MGA was observed in 7.5% of cases, and the motor branch of the median nerve in 50 upper limbs [6]. MGA is classified into three types depending on the level of origin of the anastomosis from the median nerve. Type I originates from the branch of the median nerve to the superficial forearm flexor muscles, Type II from the median nerve itself and Type III from the anterior interosseus nerve.

The purpose of our study was to determine the incidence of MGA in the Bosnian population and to measure velocities of nerves and axons involved in MGA. Knowledge of this crossover is of crucial importance in the clinical evaluation of the median and ulnar nerve and represent a major importance in the assessment of traumatic or entrapment nerve lesions.

## Materials and Methods

Data were collected from 60 healthy volunteers (120 forearms) to whom we performed EMNG analysis of upper extremities in order to find MGA. Average age of patients in this study was 52 years ( $SD \pm 12$  years), 25 women and 35 men. Volunteers with peripheral neuropathies of upper extremities were not included in this study. Informed consent was obtained, and all performed procedures were reviewed and approved by Ethical Committee of University Clinical Centre Tuzla.

The median and ulnar nerves were stimulated at the wrist and at the elbow percutaneously using needle electrodes which are placed on the standard recording, reference and stimulation points. Compound muscle action potentials (CMAPs) were recorded and the amplitude of each CMAP was measured from the negative to positive peak of the response (peak to peak amplitude). We performed median and ulnar nerve motor conduction studies by recording the thenar and hypothenar muscles, stimulating both nerves at distal and proximal points [7]. Needle recording electrodes were placed on the opponens pollicis and abductor digiti minimi (ADM). CMAP from the thenar and/or thenar muscles, larger (at least 1.0 mV) upon median nerve stimulation at the elbow than at the wrist, and CMAP from one or more of these sites larger (at least 1.0 mV) upon stimulation of the ulnar nerve at the wrist than at the elbow were accepted as indicators of the presence of the MGA [8].

Electrophysiological investigations were carried out on two channel electromyograph (Medelec Synergy, Oxford Instruments by using needle electrodes, surface electrodes and stimulation electrodes from the same producer).

Chi-square test and student t-test were used to statistically evaluate the data.

## Results

One hundred and twenty forearms from the sixty healthy volunteers admitted to the Department of Neurology were examined electrophysiologically. Out of 60 healthy volunteers, abnormal forearm anastomosis consisting of fibres originating from the median nerve and joining the ulnar nerve was noted in 20 (33.3%) volunteers. The total number of anastomoses in the women group was 11 (55%) whereas in the men group was 9 (45%). No statistically significant difference was found between men and women regarding the frequency of the MGA anastomosis. The MGAs was bilateral in 7 and present only in one arm in 13 patients. Out of 13 unilateral MGA, 9 (69.23%) was registered in right and 4 (30.77%) in left hand and that was significantly important (Table 1).

**Table 1: The incidence of Martin-Gruber anastomosis in healthy volunteers.**

Martin-Gruber anastomosis		Total
Unilateral	Left	9
	Right	4
Bilateral		7
Total number		20

The average of motor velocity in right median nerve in subjects with MGA was 54.47 m/sec ( $SD \pm 5.2$ ) whereas in left median nerve was 56.85 m/sec ( $SD \pm 5.7$ ). In the same group of subjects, average velocity in right ulnar nerve was 55.59 m/sec ( $SD \pm 5.1$ ) while in left ulnar nerve was 55.08 m/sec ( $SD \pm 6.6$ ). No statistically significant difference was found regarding the velocity in median and ulnar nerves in subjects with MGA.

The average motor velocity in right median nerve with axonal innervation of musculus abductor digiti minimi was 59.26 m/sec ( $SD \pm 5.8$ ), while the same velocity for the left median nerve was 59.56 m/sec ( $SD \pm 5.8$ ). The average motor velocity in right ulnar nerve with axonal innervation of musculus opponens pollicis

was 59.18 m/sec (SD  $\pm$  7.8), while the same velocity for the left ulnar nerve was 61.91 m/sec (SD  $\pm$  9.4) (Table 2).

**Table 2: The motor velocity in examined nerves and anastomosis.**

Nervus	Motor velocity (m/sec) (X $\pm$ SD)	Motor velocity median nerve with axonal innervation of abductor digiti minimi (X $\pm$ SD)	Motor velocity ulnar nerve with axonal innervation of opponens pollicis (X $\pm$ SD)	P
<b>Right</b>				
Median nerve	54.47 $\pm$ 5.2	59.26 $\pm$ 5.8	-	0.07
Ulnar nerve	55.59 $\pm$ 5.1	-	59.18 $\pm$ 7.8	0.04
<b>Left</b>				
Median nerve	56.85 $\pm$ 5.7	59.56 $\pm$ 5.8	-	0.43
Ulnar nerve	55.08 $\pm$ 6.6	-	61.91 $\pm$ 9.4	0.003

In subjects with MGA, when stimulating median nerve the respond of abductor digiti minimi was registered in 11 (55%), whereas the respond of opponens pollicis when stimulating ulnar nerve was registered in 18 (90%). Statistically significant higher incidence of MGA axonal innervation was found in opponens pollicis compared to abductor digiti minimi.

## Discussion

Anastomosis between median and ulnar nerves in the forearm are of phylogenetic significance. It has been estimated that in the forearms of 15% to 31% of individuals, motor axons descend from the median nerve, crossing the ulnar nerve and ultimately innervating intrinsic hand muscles which are normally supplied by the ulnar nerve [9]. In electrophysiological studies the incidence of MGA ranging from 15% to 31% in normal or unselected subjects. Mannerfeld was the first used electrodiagnostic techniques to detect MGA. He reported the incidence of 15% in a study of 41 patients [10]. Crutchfield and Gutmann found an incidence of 28% in general population and 62% in relatives [11]. Uchida and Sugioka determined the incidence of MGA in patient without and with cubital tunnel syndrome and found in the normal controls that the incidence of MGA was 16% [12]. In our study the incidence of MGA was found to be 33.3%. No statistically significant difference was found between men and women regarding the frequency of MGA cases. It has been suggested that unilateral MGA occurs more often in the right side than the left. In our study, MGAs were also found more often on the right side and the difference was statistically significant.

In electrodiagnostic studies the highest incidence of MGA was found for first dorsal interosseus (FDI) muscle. According to Wilbourn and Lambert anomalous axons much more commonly innervated FDI than the

hypothenar and thenar [13]. Gutmann studied 13 extremities with MGA and found that anomalous innervation was present in all of the ADM and FDI muscles and in 61% of the thenar muscles. Kimura studied 656 forearm and found MGA in 96 arms (15%). In 63 (82%) of the 77 tested hands both the hypothenar and thenar muscle groups were innervated by the communicating fibers. Anomalous innervation was limited to the hypothenar muscle in 13 (18%) and to the thenar muscles in one hand (1%). Kimura did not record from the FDI eminence [14].

In our study, we found MGA in 20 volunteers (27 arms). When stimulating median nerve the respond of ADM was registered in 11 (55%) cases, whereas the respond of opponens pollicis when stimulating nervus ulnaris was registered in 18 (90%). In our study, statistically significant higher incidence of MGA axonal innervation was found in thenar muscle compared to hypothenar muscle. We did not recorded from the FDI eminence. This was an expected result in view of earlier literatures analyses.

When we compared the motor velocities of median and ulnar nerves in subjects with MGA, no statistically significant difference was found. Statistically significant difference was found when we compared the motor velocity of right median nerve and motor velocity of right median nerve with axonal innervations of musculus abductor digiti minimi ( $p=0.07$ ), as well as when we compared the motor velocity of right/left ulnar nerve with motor velocity of right/left ulnar nerve with axonal innervations of thenar muscle ( $p=0.04$ ;  $p=0.003$ ). In this case, the motor velocity of ulnar nerve with axonal innervations of thenar muscle was high on the both sides, ranging from 52.5 m/sec to 71.4 m/sec. This could be an important finding because the high motor velocity of ulnar nerve requires an attention of possible MGA. This confirms electrophysiological evidence that median to ulnar nerve anastomosis convey motor fibers from median to ulnar nerve in the forearm for innervations of the intrinsic muscles in the hand [15].

The presence of Martin-Gruber anastomosis in the forearm results in unusual innervation of hand muscles. MGA has been shown to cause confusion in the assesment of nerve injuries, cubital tunel syndrome, compresive neuropathies and traumatic lessions of median and ulnar nerves. This anastomosis can be diagnosed by detecting the difference in the compound muscle action potential (CMAP) recorded from the hand muscles when the median and ulnar nerves are electrically stimulated at the wrist and the elbow. We

concluded that MGA has a relatively high incidence in the Bosnian population. Because of its high incidence and because of the above electrodiagnostic consideration, MGA should be recognised to be a great clinical importance when making correct diagnosis and whilst planning appropriate therapy in peripheral lesions of the median and ulnar nerves.

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