Electrophysiological Evaluation of the Incidence of Martin-Gruber Anastomosis in Healthy Subjects

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INTRODUCTION

In our practice we encountered a certain number of cases, that were referred for electrophysiological investigation for example cases with clinical carpal tunnel syndrome, in which a motor response (M response) might be elicited from the thenar muscles upon stimulation from the elbow, but no response could be obtained upon stimulation from the wrist. Good responses were obtained in these cases with both distal and proximal stimulation of the ulnar nerve. On another occasion, in the case of an ulnar nerve lesion we could not find any denervation in the hypothenar muscles. However, there were profuse denervation potentials in the first dorsal interosseous muscle (FDI). These unusual findings can be explained by the presence of abnormal innervation of the hand muscles. Communication between the median and ulnar nerves in the hand and in the forearm provides variations in the innervation of the intrinsic hand muscles, as proved by anatomical and nerve conduction studies. Median-ulnar nerve anastomosis in the forearm is the most common form of anomalous innervation. This anomaly was first described by the Swedish anatomist R. Martin in 1763 and later by Gruber in 1870 and is thus referred to as the Martin-Gruber anastomosis (MGA). This anastomosis involves axons leaving either the main trunk of the median nerve or the anterior interosseous nerve, crossing through the forearm to join the main trunk of the ulnar nerve and ultimately innervating the intrinsic hand muscles. Although a significant number of axons may participate in this anomalous route, not all of the axons of the median nerve are involved. The axons in this
anastomosis may innervate any of the intrinsic hand muscles, most commonly the FDL. Less commonly the anastomosis does not join the ulnar nerve directly but innervates the flexor digitorum superficialis or the flexor digitorum profundus. In the type I anastomosis the crossover fibers terminate in the hypothenar muscle, in the type II — in the FDI and in the type III — in the thenar muscle group. The anastomosis involves almost exclusively motor axons. Involvement of sensory axons is unusual but has been reported in one case by Santoro et al. MGAs have been reported to be bilateral in between 10% to 40% of cases. When present, unilateral MGA occurs more frequently in the right arm than in the left. This anomaly seems to be inherited in an autosomal dominant mode.

The purpose of this study was to determine the incidence of MGA in a sample of the Turkish population and to draw the attention of the clinician-electromyographer to the possible presence of this anastomosis, a knowledge of which is of major importance in the assessment of traumatic or entrapment lesions of the median and ulnar nerves.

MATERIALS AND METHODS

Patient selection

100 healthy volunteers ranging in age between 17 and 65 (mean 37.6 ± 12.9) years were selected for the study from hospital staff and Physical Medicine and Rehabilitation Department outpatients who had no complaints concerning upper extremities. 60 of them were female and 40 were male. Subjects with peripheral neuropathies were excluded from the study.

Technique

Surface recording electrodes were placed on the right hand abductor pollicis brevis (APB), abductor digiti minimi (ADM) and the FDI of each of the subjects and were left in the same positions during the whole of the electrophysiological testing. The medianus and ulnaris nerves were stimulated at the wrist and at the elbow percutaneously using surface electrodes. The electrodes were placed on the standard recording, reference and stimulation points. Rectangular pulses of 0.2 msec duration were used and the stimulus strength was supramaximal. Compound muscle action potentials (CMAPs) were recorded and the amplitude of each CMAP (A-CMAP) was measured from the negative to the positive peak of the response (peak to peak amplitude). CMAP from the FDI, hypothenar, 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.

Electrophysiological investigations were carried out on a four channel electromyograph (Navigator version 2.01, model 996, Biologic).

Chi-square test was used to statistically evaluate the data.

RESULTS

MGAs were found in 27 of the 100 hands tested: 21 were type II, three were type I, two type I + type II and one type III. The total number of anastomoses was 29. In the group of 60 women 12 subjects (%20) were found with MGA. 10 women (%16.7) had type II, 1 (%1.7) type I + type II and 1 (%1.7) type III MGA. The total number of anastomoses in the women group was thus 13. Sixteen (%37.5) of the 40 male subjects had MGA. In 11 (%27.5) of the cases the MGAs were type II, 3 (%7.5) type I and 1 (%2.5) type I + type II. The total number of MGAs in the male group was 16. The numbers of men and women with different types and combinations of MGAs are shown in Table I, and the distributions of the different types of MGAs in the sexes are summarized in Table II. Highest incidence was found for type II MGA. No statistically significant difference was found between the numbers of men and women with MGA. No differences were found with respect to the frequencies of MGA or MGA types for the sexes.
Table 1: Distribution of MGA and their Combinations in the Studied Subjects

<table>
<thead>
<tr>
<th>SEX</th>
<th>Type I</th>
<th>Type II</th>
<th>Type I + Type II</th>
<th>Type III</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>F (n=60)</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>16.7</td>
<td>1</td>
</tr>
<tr>
<td>M (n=40)</td>
<td>3</td>
<td>7.5</td>
<td>11</td>
<td>27.5</td>
<td>1</td>
</tr>
<tr>
<td>F+M (n=100)</td>
<td>3</td>
<td>3</td>
<td>21</td>
<td>21</td>
<td>2</td>
</tr>
</tbody>
</table>

F, female; M, male.

Table 2: Incidence of the Different Types of MGA

<table>
<thead>
<tr>
<th>SEX</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>F (n=60)</td>
<td>1</td>
<td>1.7</td>
<td>11</td>
<td>18.3</td>
</tr>
<tr>
<td>M (n=40)</td>
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<td>10</td>
<td>12</td>
<td>30</td>
</tr>
<tr>
<td>F+M (n=100)</td>
<td>5</td>
<td>5</td>
<td>23</td>
<td>23</td>
</tr>
</tbody>
</table>

DISCUSSION

In anatomic studies the incidence of MGA according to Gruber was 15.2%, according to Thomson 15.5%, according to Hirasawa 10.5%, and according to Nakashima 21.3% and to Taams 23%. Mannerfelt was the first to use electrodiagnostic techniques to detect MGA and reported a 15% incidence in a study of 41 patients. Crutchfield and Gutmann found an incidence of 28% in the general population and 62% in 29 relatives of 5 subjects with MGA. Several other authors, using electrodiagnostic techniques, have reported incidences of MGA ranging from 8% to 26% in patients with carpal tunnel syndrome (CTS), and 15-39% in either normal or unselected subjects. Uchida and Sugiioka determined the incidence of MGA in patients without and with cubital tunnel syndrome and found an incidence of 16% in the normal controls and 17% in the cubital tunnel syndrome group.

In our study of the electrophysiologically normal subjects the incidence of MGA was found to be 27%. In 21 of the cases the anastomosis was of type II, in two type I + type II and in one type III.

In other electrodiagnostic studies the highest incidence of MGA was also found for the FDI muscle. Wilbourn and Lambert reported that anomalous axons innervate the FDI muscle much more commonly (95%) than the hypothenar (41%) and thenar (14%). In 22 limbs showing the anomaly the anastomotic median axons innervated the FDI area 21 times, the hypothenar 9 times and the thenar 3 times. Gutmann studied 13 extremities with MGA and reported that anomalous innervation was present in all of the ADM and FDI muscles and in 61% of the thenar muscles. Uchida and Sugiioka who recorded from ADM and FDI muscles found that the FDI muscle was innervated by the communicating branch more often than the ADM. Kimura studied 656 arms of 328 subjects using the collision technique. MGA was found in 57 (17%) subjects and 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 muscles in 13 (18%) and to the thenar muscles in one hand (1%). Kimura did not record from the FDI eminence.

No statistically significant difference was found between men and women regarding the frequency of MGA cases. This was an expected result, in view of earlier analyses, which indicated autosomal dominant inheritance of these innervation variants.

In all of the cited studies and in our study also the incidence of type II MGA was relatively high. Fortunately, this does not present any difficulty in routine ulnar nerve conduction studies, because the recording electrodes are not placed on this
muscle. A potential difficulty arises in cases of suspected lesions in the deep palmar branch of the ulnar nerve, because the recording electrodes should be placed on the dorsal interosseous muscle.

Type I MGA is a more serious source of confusion in ulnar nerve conduction studies. In cubital tunnel syndrome, CMAPs of proximal stimulation are lower than the CMAPs obtained by distal stimulation, and this is always the finding in subjects with a MGA who do not have nerve palsy. To make the correct diagnosis it is important to rule out MGA by appropriately stimulating the median nerve. The hypothenar CMAP is evoked by elbow stimulation whereas wrist stimulation evokes little or no response.

The presence of MGA is the source of diagnostic difficulty in the cases of CTS. Normal motor latencies are obtained in such cases. However, there are certain clues to the correct diagnosis:

- Median nerve stimulation at the elbow evokes a thenar CMAP with an initial positive deflection not seen on stimulation at the wrist. 16

- A thenar CMAP with two peaks in the negative phase is seen upon median nerve stimulation at the elbow. 17

- An erroneously normal proximal (elbow) motor latency in the median nerve with prolongation of the distal motor latency results in a spuriously fast conduction velocity by calculation. 18,19

MGA has been shown to cause confusion in the assessment of nerve injuries, 20-24 cubital tunnel syndrome 2 and leprosy neuropathy. 25

We concluded this study shows that MGA is a fairly common finding in healthy subjects in the Turkish population. Because of its high incidence and because of the above electrodiagnostic considerations, MGA should be recognized to be of great clinical importance when making correct diagnosis and whilst planning appropriate therapy in peripheral lesions of the median and ulnar nerves.

REFERENCES

20. Bergman FO, Blom SEG, Stenström SJ. Radical excision of a fibrofatty proliferation of the median nerve, with no neurological loss symptoms. Plast Reconstr Surg