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Research Article

Analysis of Compound Muscle Action Potential of Median and Ulnar Nerves: Possible Anatomical Correlation

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ABSTRACT

Objective: To analyze of shape, amplitude of CMAP of both median and ulnar in normal population and to analyze the anatomical innervations of small muscles of hand in normal cadavers.

Design: Cross sectional study.

Settings: outpatient settings and department of anatomy at Alexandria University.

Participants: 300 normal adults (82 males and 218 females) and 30 normal adult cadavers.

Main outcome measures: Motor conduction study of both median and ulnar nerves for the included normal subjects. Surface recording of CMAP from thenar and hypothenar muscles respectively with analysis of the shape of the waveform and amplitude.

The nerve supply of both thenar and hypothenar muscles were dissected for the included normal cadavers. The main nerve trunk (median or ulnar), the number of branches, their sizes and their sites of entering into the muscles were recorded.

Results: The mean age of the studied population was 37.86 ± 8.83 (age range 19-69). The mean amplitude of the median nerve was significantly higher than that of the ulnar nerve (11.785 ± 5.0, 10.45 ± 2.96 respectively, p=0.0001). The mean distal latency of median nerve was significantly higher than that of ulnar nerve (3.38 ± 0.41 and 2.698 ± 0.40 respectively, p=0.0001).

The median nerve had mostly dome shaped CMAP rather than double peaked CMAP with significant difference (p=0.0001), while the shape of CMAP of the ulnar nerve was more frequently double peaked rather than dome shaped with significant difference (p=0.0001). The mean distal latency of the median nerve was significantly longer in those with dome shaped CMAP rather than those with double peak CMAP (p=0.002). Similarly, the mean distal latency of the ulnar nerve was significantly longer in those with dome shaped CMAP compared with those with double peak CMAP (p=0.0001). There were no statistical significant differences between the amplitude of dome shaped CMAP and the double peaked CMAP in either the median or the ulnar nerve.

The anatomical results showed that abductor pollicis brevis supplied by the median nerve in 90% of specimens, and by both nerves in 10%. The abductor digiti minimi brevis supplied by the deep branch of the ulnar nerve in 90% and by superficial branch of the ulnar nerve in 10%. There was a connection between the median and ulnar nerves in 50% of specimens.

Conclusion: The configuration of the CMAP of the median nerve is mostly dome, whereas that of the ulnar is mostly double peaked. Variability in the pattern of innervations of the small muscle of the hand could be a possible etiological factor.

Keywords: Anatomical innervations; Cross sectional study; CMAP; Thenar and hypothenar muscles

INTRODUCTION

The ulnar hypothenar compund muscle action potential (CMAP) often shows a double peaked configuration in the negative phase component while the median, thenar potential has a simple dome shape [1]. Revising the literature in this context showed no conclusive data. One study suggested that the tendon sites are

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not electrically inactive. The ulnar tendon electrode contributes largely to the second peak of the ulnar belly-tendon potential. The median tendon electrode contributes only a minimal component to the negative phase of the belly-tendon potential [1].

Another study investigated the hypothenar CMAP and concluded that the first peak of the negative phase of the CMAP comes from the hypothenar muscles but the second peak is due to a large volume conducted potential from the interosseous muscles [2].

Van Dijk, et al. [3] maped the spatial and temporal dispersion of CMAP. Thenar maps had one peak (spatially and temporally) with high amplitude zone of 3.5 ± 2.3 cm. Hypothenar maps had two peaks (spatially and temporally) with a high amplitude zone of 7.7 ± 3.6 cm. Wave form differences were ascribed to difference in muscle anatomy, architecture and variability [3].

No definite explanation for the variation of the configuration of CMAP of the median and ulnar nerves. From the anatomical point of view, significant variation is recognized in the innervations of the intrinsic muscles of the hand [4,5].

The innervations of thenar and hypothenar muscles originated generally from median and ulnar nerves respectively [6]. The existence of double nerve supply to the thenar and hypothenar muscles is emphasized by Harness and Sekeles [7]. They are subject to more variations than that of any other muscle in the body [7].

The abductor pollicis brevis (APB) muscle is supplied mainly by the recurrent branch of the median nerve or the lateral terminal branch of the median nerve [8]. However, it can be supplied by the ulnar nerve or receive dual innervations from the median and ulnar nerves [9].

The nerve supply of flexor pollicis brevis muscle is subject to more variations than that of any other muscle in the body. It can be supplied by the median nerve, ulnar nerve or both nerves [10].

The abductor digiti minimi (ADM) muscle is supplied mainly by the deep branch of the ulnar nerve [5]. It may receive innervations from the superficial branch of the ulnar nerve, together with the third and fourth lumbricals [5]. The lumbricals classic innervations originate from the median nerve for the lateral two muscles and from the deep branch of the ulnar nerve for the medial two muscles but considerable variations exist. The 3rd and 4th lumbricals may receive nerve supply from the superficial division of the ulnar nerve [11].

AIM

1. To analyse of shape, amplitude of CMAP of both median and ulnar nerves

2. To analyse anatomical innervation of small muscles of hand.

SUBJECTS

300 normal subjects (82 males and 218 females) from those attending the outpatient clinic of Physical Medicine, Rheumatology and Rehabilitation department, Alexandria University volunteered in the study. All the included subjects signed informed consent. They had no neurological diseases that can affect their nerves.

10 normal cadavers from those present at the department of Anatomy, faculty of medicine, Alexandria University were included for anatomical study.

METHODS

Motor conduction studies of both median and ulnar nerves were done for the included subjects. Nehon Coden machine was used to conduct the tests. Surface recording using round silver 1 × 1 cm in diameter electrodes. The electrodes were applied to the skin through the use of collodion after cleansing of the skin with alcohol prior to application [12]. The standardized motor conduction study of median nerve was done. The conventional sites of stimulation at wrist, elbow, axilla and Erb's point were done, with recording from APB, active electrode over motor point and reference electrode over the tendon. The ground electrode was placed between active and stimulating electrodes [12]. Similarly, routine motor conduction study of the ulnar nerve was carried out with stimulation at multiple sites; wrist, below elbow, elbow, above elbow and Erb's point. Recording from ABD was done with active electrode over motor point and reference electrode over the tendon. The ground electrode was placed between active and stimulating electrodes [12]. Those who had normal motor conduction study of both median and ulnar nerves were included in the study. Analysis of the shape of CMAP, amplitude and distal latency were performed.

Anatomical section

The study was carried out on 10 cadavers, both sides were dissected. The median and ulnar nerves were exposed and dissected as they enter and supply the muscles of the hand.

All the muscular branches of both nerves were identified and followed out throughout their course. The number of these branches and their points of entry into the muscles were identified as well as the connecting loops between the median and ulnar nerves.

Statistical analysis

Statistical analysis was done using Statistical Package for Social Sciences (SPSS/version 15) software. Arithmetic mean, standard deviation, for numerical data t-test was used to compare between two groups. While for categorical data, Z-test was used. The level of significant was 0.05.

RESULTS

Electrophysiological results

Seventy two percent of the studied subjects were females, while male constituted only 27% with significant difference between both sexes (Table 1). The mean age of the studied subjects was 37.86 ± 8.8 (age range 19-69). The mean amplitude of median nerve (11.78 mv) was significantly higher than that of the ulnar nerve (10.45 mv) (Table 2).

Variable	Number and percentage	Significance
Gender n%		
Male	82(27.3%)	Z-test 12.4
Female	218(72.7%)	p 0.0001*
*Significant p ≤ 0.05		

Table 1: Sex distribution of the studied subjects.

		Mean	SD	T	p
Amplitude	Median Amp.	11.7855	5.00068	5.475	0.0001*
	Ulnar Amp.	10.4522	2.96229		
D.L.	DL median	3.3847	0.41506	12.795	0.0001*
	DL ulnar	2.698	0.40498		
Shape		Frequency	Percent	Z test	p
	Median		Male	Male	Male
	Dome	217	72.7	12.28	0.0001*
	Non-dome	83	27.7		
	Ulnar		Male	Male	Male
	Dome	34	11.3		
	Non-dome (doublepeaked)	266	88.7	19.23	0.0001*
*Significant p ≤ 0.05					
Abbreviations: Amp: Amplitude; DL: Distal Lateney; SD: Standard Deviation					

Table 2: Comparison between median and ulnar nerve regarding DL, amplitude and shape of CMAP.

The mean DL of the median nerve (3.38 msec) was significantly longer than that of the ulnar nerve (2.6 msec) (Table 2). The median nerve CMAP was mostly dome shaped, (Figure 1) rather than double peaked (Figure 2). Whereas CMAP of the ulnar was more frequently non dome i.e double peaked (Figure 3) rather than dome shaped (Figure 4) (Table 2).

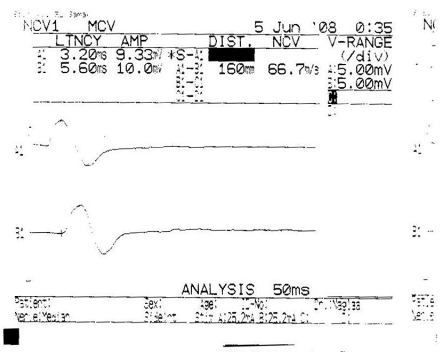

Figure 1: Median nerve CMAP (Dome shaped).

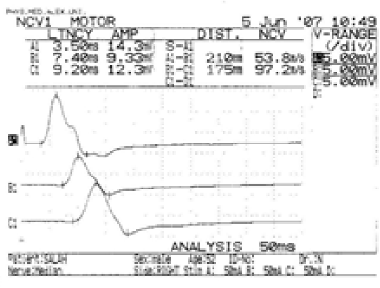

Figure 2: Median nerve CMAP (Double peaked; Non dome).

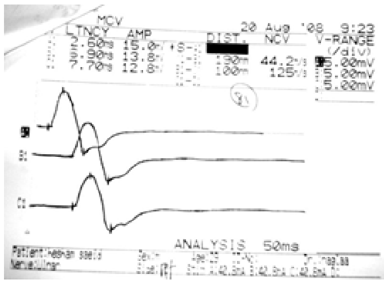

Figure 3: Ulnar nerve CMAP (Dome shape).

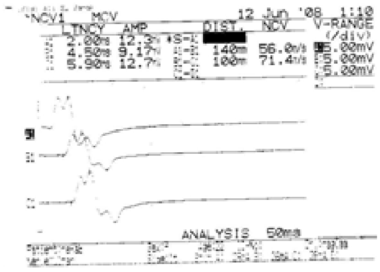

Figure 4: Ulnar CMAP (Double peaked; non dome).

Mean DL of median nerve was significantly longer in those with dome shaped CMAP rather than those with double peaked CMAP. Mean DL of ulnar nerve was significantly longer in those with dome shaped CMAP rather than those with double peaked CMAP (Tables 3 and 4).

		N	Mean	S.D.	Min.	Max.	t	p
DL median	Non dome	83	3.2639	0.42299	2.6	4.2	5.015	0.002*
	Dome	217	3.4309	0.40348	2.7	4.3		
Median amp.	Non dome	83	11.0335	4.46131	5.2	21.8	2.609	0.107
	Dome	217	12.0731	5.17297	3.9	25.3		
*Significant p ≤ 0.05;								
Abbreviations: Amp: Amplitude; DL: Distal Lateney; SD: Standard Deviation								

Table 3: Relation between shape of CMAP of median nerve and DL and Amplitude.

		N	Mean	S.D.	Min.	Max.	t	p
DL ulnar	Non dome	266	2.6677	0.3761	1.7	4	3.725	0.0001*
	Dome	34	2.9353	0.53365	2	3.5		
amp ulnar	Non dome	266	10.512	2.7378	5.9	18.7	0.963	0.317
	Dome	34	9.9826	4.366	3.5	16.3		
*Significant p ≤ 0.05;								
Abbreviations: Amp: Amplitude; DL: Distal Lateney; SD: Standard Deviation								

Table 4: Relation between shape of CMAP of ulnar nerve and DL and Amplitude.

There were no statistical significant differences between the amplitude of dome shaped CMAP and double peaked CMAP in either median or ulnar nerves (Tables 3 and 4).

Anatomical results

The APB received nerve supply from the median nerve in 90%

of the specimens (Figure 5) and double innervations from both median and ulnar nerves in 10% of the specimens (Table 5).

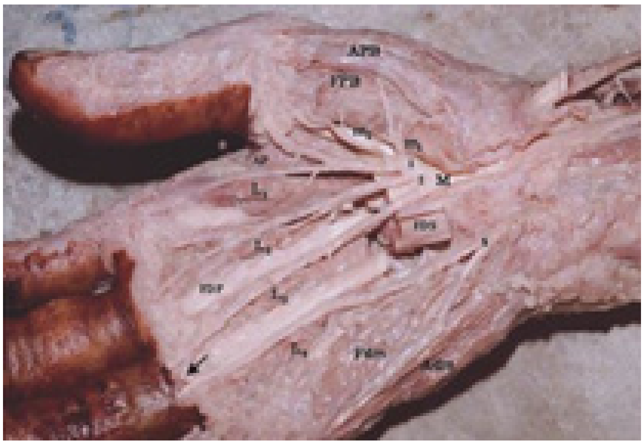

Figure 5: A photograph of a right palm showing the median nerve (M) entering the hand and dividing into lateral (1) and medial (2) divisions. The lateral division gives 2 muscular branches to flexor pollicis bresis muscle (FPB): ml which passes superficial to the muscle fibers and m2 which passes through the middle of the muscle fibers, and each one divides into 3 smaller branches before supplying the muscle and passing to abductor pollicis brevls muscle (APB) then its gives a mincular branch that supplies the first lumbrical muscle (LI). The medial division gives two muscular branches to the second and third lumbricals (1.2. L3). The superficial branch of the ulnar nerve (s) is seen dividing into medial and lateral digital branches. There is a loop connection (pointed by an arrow) between the lateral digital branch of the ulnar nerve and the most medial digital branch of the ulnar nerve. Note flexor digit' minind (Fdm) and Abductor digit' mWnJ (Adm) muscles.

	Median nerve	Ulnar nerve	Both
Flexor pollicis brevis	40%	10%	50%
Abductor pollicis brevis	90%	0%	10%
Opponens pollicis	80%	10%	10%
Adductor pollicis	0%	90%	10%

Table 5: Nerve supply of the muscles of the thenar muscles.

The patterns of innervations of APB from the median nerve were different (Table 6). Usually, the branches supplying the muscle from the recurrent branch (Figure 6), lateral division or both are close to each other. Infrequently, APB received branches distant from each other (Figure 7).

Number of muscular branches from the median nerve	%	origin	Point of entry
One branch	20%	Recurrent 10%-Lateral division 10%	Near the origin Into the middle of the muscle
Two branches	40%	Lateral division	One branch near the origin. The other branch into the middle of the muscle
Three branches	30%	One from the recurrent. Two from the lateral division	Enter near the origin. One enters the middle of the muscle-The other branch enters near the insertion

Table 6: Pattern of nerve supply of abductor pollicis brevis muscle.

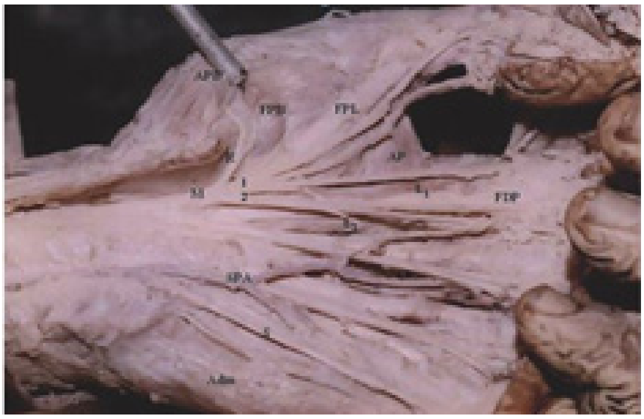

Figure 6: A photograph of a left plam showing the median nerve (M) giving a recurrent (R) muscular branch as its first branch that supplies flexor pollicis brevis (FPB) and abductor pollicis brevis (APB) muscles, the nerve enters through the proximal part of the muscles near their origin. Then the median nerve divides into lateral (1) and medial (2) divisions. The lateral division supplies the first hunbrical muscle (LI) and adductor pollicis muscle (AP) and the medial division supplies the second lumbrical muscle (L2). 5: Superficial branch of ulnar nerve, FPL: Tendon of flexor poilicis longus muscle. FDP: Tendon of flexor digitonun profundus muscle, SPA: Superficial palmar arch and Abductor digiti ndnimi (Adm) muscle.

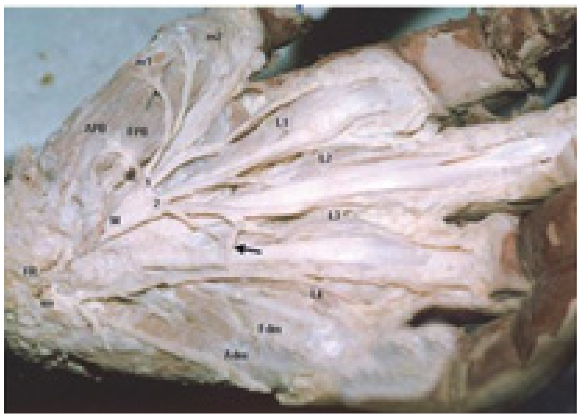

Figure 7: A photograph of a left palm showing the median nerve (M) entering the hand deep to the flexor retinaculum (FR) and giving a recurrent branch (R) that supplies the proximal parts of the abductor (APB) and flexor (FBP) pollicis brevis muscles, then it divides into lateral (1) and medial (2) divisions, the former gives 2 muscular branches (m1 and na) which supply the distal parts of APB and FPB respectively, and gives a branch to the first lumbrical muscle (L1). The latter supplies the 2nd (1.2) and third (L3) lumbricals and gives an anastomotic loop marked by an arrow. The superficial branch of the ulnar nerve (un) which supplies the fourth lumbrical (1.4) and the abductor digiti minimi muscle (Adm).

Table 5 presented that flexor pollicis brevis (FPB) received nerve supply from the median nerve alone in 40% of the specimens (Figure 8) and from the ulnar nerve alone in 10% of the specimens (Figure 9). FBP received innervations from both nerves median and ulnar in 50% of specimens (Figure 10).

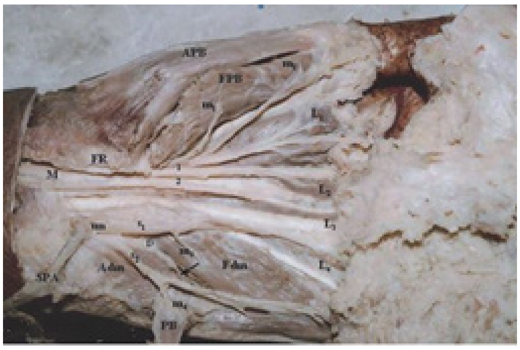

Figure 8: A photograph of a left plain showing the median nerve (M) entering the hand deep to the flexor retinaculum (FR) and dividing into lateral (1) and medial (2) divisions, the lateral division gives 2 muscular branches: m-1 that enters the middle of flexor pollicis brevis muscle (FPB)and m2 that enters the muscle near Its insertion. it also gives 2 muscular branches to the first and second luntbricals (L1, L2) the medial division gives muscular branch to the third lumbtical muscle (L3). The ulnar nerve (un) divides Into two superficial branches (sl, s2) and one deep branch (D) which gives a branch (pointed by an arrow) to abductor digits ntinind muscle (Adm), sl gives a muscular branch (m3) to flexor digiti minimi muscle (Irdm) while S2 gives a muscular branch (m4) to ipalmaris brevis muscle (PB). SPA: Superficial palmar arch is cut and reflected proximally.

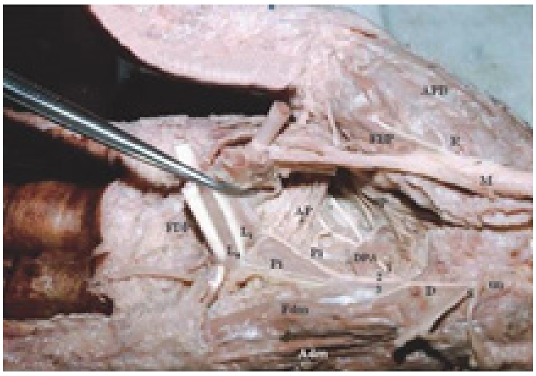

Figure 9: A photograph of the right palm showing the tendons of the flexor digitorum profundus muscle (FDP) which are cut and reflected distally to show the Ishtar nerve (un) dividing into superficial (S) and deep (D) branches. The deep branch of the ulnar nerve gives 3 branches (1.2,3), the lateral branch (1) passes deep to the deep palmy arch (DPA) and divides into two branches which supply the deep part of flexor pollicis broils (FPS), opponens poWcis (op) and adductor pollicis (AP) muscles. The middle one (2) passes superficial to DPA and divides Into 2 smaller branches that pass Into and supply the 3rd and 4th lumbricals (L3, L4) through their deep surface and the palintw Interossel (P1). The medial branch (3) supplies the flexor digit! minim' (Fdm) and abductor WO minim (Adm) muscles. The median nerve (M) gives a recurrent muscular branch: (It) that supplies flexor pollicis brevis (FPB) and Abductor pollicis brevis (APB) muscles.

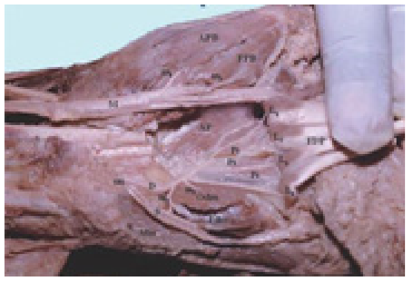

Figure 10: A photograph of a left palm showing the median nerve (M) giving two muscular branches (ml, m2) to abductor pollicis brevis (APB) and flexor pollicis brevis (FPB) muscles respectively and continues to supply the first lumbrical muscle (Ll). The ulnar nerve (WI) divides into superficial (S) and deep (D) divisions. Tht deep division gives muscular branches (m3) to opponens digiti minhul (Odin) muscle and (m4) to the flexor diglti mWntl (Fdm) and abductor digiti miniM (Adm) then passes laterally supplying muscular branches to the deep surface of the four lumbricals (L1,12,13,1.4) and ends by supplying the adductor pollicis muscle (AP) and the deep part of flexor pollicis brevis. The tendons of the flexor digitorum prolbndus muscle (FDP) are cut and reflected distally. The nerves to the lumbricals pass on the surface opt the palmar Interossei (Pi) and supply them.

Abductor digiti minimi (ADM) muscle received one branch from deep branch of the ulnar nerve in 90% of the specimens (Figures 9 and 10) and from superficial branches of the ulnar nerve in 10% of the specimens (Figures 5-7) (Table 7).

	Deep branch of ulnar nerve	Superficial branch of ulnar nerve
Flexor digiti minimi brevis	90%	10%
Abductor digiti minimi brevis	90%	10%
Opponens digiti minimi	100%	0%

Table 7: Nerve supply of the muscles of the hypothenar muscles.

Simultaneous branches from the deep branch of the ulnar nerve to 3rd lumbrical muscle (70% of the specimens) and to 4th lumbrical muscles(100% of the specimens) and to the palmar interossei in all the specimens (Table 8) (Figures 9 and 11).

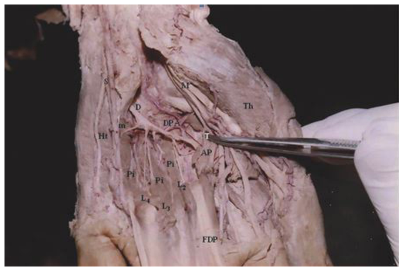

Figure 11: A photograph of a left palm showing the deep branch of the ulnar nerve (D) passing superficial to the deep palmar arch (DPA) and giving muscular branch (m) to the hypothenar muscles (lit) and then continues laterally to supply the medial three lumbricals (L2. L3.L4) and the palmar Interossel (Pi) and ends by supplying the adductor pallets muscle (AP). The tendons of flexor digitortun profundus muscle (FDP) are cut and reflected distally. The median nerve (M) glees a small twig (1) to the adductor polite's muscle. Th: Thenar muscles. S: Superficial branch of ukrar ierve.

	Median nerve	Ulnar nerve	Both
1st lumbrical	95%	0%	5%
2nd lumbrical	80%	20%	0%
3rd lumbrical	30%	70%	0%
4th lumbrical	0%	100%	0%

Table 8: Nerve supply of the lumbrical muscles.

There was a connection between the median and ulnar nerves in 30% of the specimens (Figure 5). In those cases, APB received nerve supply from the median nerve only.

DISCUSSION

In the present study, mean median nerve amplitude was (11.78 mv) significantly higher than that of ulnar nerve (10.45 mv). Both Kimura [12] and Dumitru [13] found similar findings. They reported mean median amplitude was 13.2 ± 5 mv, 7 ± 3 mv respectively. That of ulnar nerve was 6.1 ± 1.9 mv, 5.7 ± 2 mv respectively. Hennessey, et al. [14] found the ulnar nerve amplitude (12.6 ± 2.3 mv) slightly higher than that of median nerve. However, he did not mention whether these differences were significant and there is no definite explanation [14].

The variability in the values of the mean amplitude of both nerves from one series to another could be secondary to racial difference. Weber [15] suggested that generally, the amplitude of the CMAP is dependent upon the synchronization of the signal's arrival. The more synchronized the signal, the greater (more spike like) the amplitude. Thus amplitude varies inversely with the dispersion of the evoked response [15]. Since we found that CMAP of the median nerve is more frequently higher than that of the ulnar nerve. We could speculate that the synchronization of the median nerve is usually more than that of the ulnar nerve.

Also in the present study, the median nerve CMAP of was mostly dome shaped and that of the ulnar nerve was mostly double peaked. This also could be explained in light of Weber suggession [15]. Dumitru [13] and Kimura [12] mentioned that the shape of CMAP is biphasic curve. They did not mention the frequently encountered difference in the shape of CMAP between the median and the ulnar nerve [12,13].

Bromberg and Spiegellerb [16] studied the influence of the active electrode placement on CMAP amplitude and concluded that in order to record the maximal CMAP response, empirical assessment by moving the active electrode is necessary [16]. In our study, we had placed the active electrode over the standardized motor points for the abductor pollicis brevis and the abductor digiti minimi muscle for all the studied subjects so we have eliminated the influence of changing electrode placement on CMAP amplitude.

Similarly, Lateva, et al. [17] concluded that CMAP shape is related to electrode configuration and anatomical factor particularly muscle fiber length that changes with changes of thumb position [17]. These factors for changes in CMAP configuration are not applicable to our study since we used fixed standardized techniques and same electrode placement for all the studied subjects without any movement of the thumb or the little finger.

Kincaid, et al. [1] suggested that the tendon sites are not electrically inactive. The ulnar tendon electrode contribute to large extent to the second peak of CMAP i.e tendon potential. While the median tendon electrode contribute only minimally to the negative phase of the CMAP [1]. However in our study we did not record from tendon sites.

Van Dijk, et al. [3] maped the spatial and temporal dispersion of CMAP. They concluded that wave form difference are due to difference in muscle architecture and variability [3]. Moreover, our anatomical results showed that APB received mostly innervations from median nerve only. Those branches from median nerve are very close to each other from the lateral division or only one branch from the recurrent branch. Homma and Sakai [18] agreed with these anatomical results and mentioned that the APB has a separate belly and receives separate nerve branch [18]. Ajmani [5] found in his series that APB muscle supplied by median nerve alone [5]. These anatomical findings could be a possible explanation of the frequently encountered dome shaped CMAP of the median nerve i.e Why it is synchronized.

On the other hand, our anatomical results showed that abductor digiti minimi receives one branch from the deep branch of the ulnar nerve in 90% of cases. Simultaneous branches from deep branch of the ulnar nerve arise to 3rd lumbrical (70% of cases).

4th lumbrical (100% of cases) as well as palmar interossei. Revising literature in this context found similar results [18,19]. Ajmani [11] reported that the deep branch alone supplies the abductor digiti minimi. It also supplies the third and forth lumbricals in 94% of his series [11].

Our findings that the ulnar CMAP is typically double peaked could be explained in light of the anatomical findings of simultaneous branches that arise from deep branch of ulnar nerve to ADM, 3rd, 4th lumbricals and palmar interossei. So the second peak of the curve could be from volume conduction from those muscles.

Mc Gill and Lateva [2] concluded that the first peak of the negative phase of CMAP comes from the hypothenar muscles but the second peak is due to large volume conducted potential from the interosseous muscle. The interosseous contribution affects both the amplitude and the area of CMAP. However this contribution is sensitive to finger movement and temperature changes of the hand [2]. In our study, these factors are not applicable, so the anatomical explanation might be more possible.

Little percentage of the studied subjects showed double peaked CMAP of the median nerve. In light of the anatomical results, APB received double innervations from both median and ulnar in 10 % of cases. Also infrequently APB supplied by branches distant from each other from recurrent and lateral division of the median. Similar anatomical results were recorded by Mumford and Olave [20,21]. In addition, flexor pollicis brevis which is anatomically very close to APB was found in our series to receive double innervations from the median and ulnar nerves in 50% of the examined cadavers. Lo Monaco, et al. [22] agreed with these findings. These occasional anatomical findings in our series as well as in the previous literature could be a possible etiological factor for the infrequently encountered double peaked CMAP of the median nerve. In addition, ulnar to median nerve anastomosis which was found in some of our cadavers could also be possible etiologic factor. Definite etiological factor could not be detected because we could not dissect the hands of the normal studied subjects to detect the exact pattern of innervations of the thenar muscles.

Similarly, we found that in 10% of the studied cadavers, the ADM supplied by superficial branch from ulnar nerve solely. These minority of anatomical findings could be a possible etiological factor for the rarely met dome shaped CMAP of ulnar nerve.

In the present study, the mean DL of the median nerve was significantly longer than that of the ulnar nerve. There is no comment on these findings in the literature. However, Weber [15] suggested that generally, the latency depend upon number of different physiologic events; latency of activation; the time between the initiation of electrical discharge in the stimulator and the actual beginning of salutatory conduction along the axon, fast salutatory along the large myelinated axon. Slower conduction along the smaller diameter of the myelinated axon as it tapers distally. Very slow conduction along the non myelinated terminal twigs of axon [15].

Since we found that the median nerve CMAP was mostly dome shaped i.e. has better synchronization of different nerve fibers. So we could explain the longer distal latency of median nerve compared with that of ulnar nerve, because of many synchronized fibers with different conduction velocity contribute to compound muscle action potential. Hence, longer latency. Whereas, the ulnar nerve has frequently double peaked CMAP together with shorter latency compared with median nerve. This is mostly because less synchronization of fibers, hence latency could be depending mainly on the fastest conducting fibers only i.e short latency.

In addition, among each individual nerve whether median or ulnar nerve, we found that the distal latency of each nerve is significantly longer in case that CMAP shape is dome and shorter in case that CMAP is double peaked. This also supports our explanation which suggest the relationship between synchronization of CMAP and latency.

STUDY LIMITATION

We could not dissect the hands of the normal examined subjects to define the exact pattern of innervations of the thenar and hypothenar and to correlate these findings with CMAP shape. Hence, the anatomical results just raise possible etiological factors.

CONCLUSION

The configuration of the CMAP of the median nerve is mostly dome, whereas that of the ulnar is mostly double peaked. Variability in the pattern of innervations of the small muscle of the hand could be a possible etiological factor.

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