

## Electric current in abnormal nerves: The utility of the difference in the latency of median and ulnar mixed nerve action potentials in focal ulnar nerve neuropathy

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**Abstract:** We have evaluated the usefulness of the difference in latency index measurement (Dlat index) as described by K.Merlevende by studying over a period of six months 29 patients referred for neurophysiological evaluation for focal ulnar neuropathy (FUN) across the elbow and 30 normal volunteers. The upper limit of our reference value for the 30 volunteers was 1.3 ms. The Dlat index of 4 nerves out of 18 nerves with definite electro-clinical FUN across the elbow had values less than 1.0 ms. One out of 4 nerves with sub-clinical FUN had Dlat index of 1.2 ms. The 9 normal nerves had normal Dlat Index. Dlat index is less sensitive than standard electrophysiological studies in detecting FUN. An abnormal Dlat index could be used as yet another indicator to add to the multiple internally consistent abnormalities essential in diagnosing FUN.

**Keywords:** Neuropathy, Dlat index, Electrophysiological, FUN

### Introduction

The most common site of a focal ulnar neuropathy (FUN) is in its course across the elbow [1]. The neurophysiological localization of a focal pathology to this site is dependent on demonstrating abnormalities of motor and/or sensory conduction parameters of the ulnar nerve across the elbow in comparison to segments below and above the elbow [2-5]. The main difficulty associated with studying this segment of the ulnar nerve is related to defining the optimum distance to show up the presence of focal slowing of conduction and the effect of the accuracy of the measurement of such a distance on the calculation of the conduction velocity [2, 6]. To address this problem, Karen Merlvenede et al [7] have developed a method of measuring the difference between the latency of the ulnar and the median mixed nerve action potentials (MNAP). Their method entails recording MNAP of both nerves from the same position in the upper arm following the stimulation of these nerves at the same level at the wrist. They have christened this latency difference, as Dlat index. They have used this technique in ten patients with symptoms without abnormal bedside signs, but with electrophysiological evidence of FUN at the elbow, and they have found Dlat index abnormality in 9 out of their ten cases. In 24 patients with miscellaneous neurological problems, only 3 patients had

had Dlat index above their reference limit. These cases were diabetic and in two of them the standard electrophysiological parameters had been abnormal. Merlvenede et al have concluded that Dlat index is a sensitive and a specific measurement and thus a useful simple technique to screen for FUN.

In this paper we shall report our experience with this MNAP Dlat index in a group of patients with and without focal ulnar nerve neuropathy at the level of the elbow.

## **Materials and Methods**

### **Patients (Table1)**

Over a fixed period of six months, we investigated prospectively 29 patients referred to our neurophysiology clinic either to assess for a possible focal ulnar neuropathy or on attending were found to have focal ulnar neuropathy. They were 11 females and 18 males. They had a median age of 48.5 years ranging from 26 years to 65 years. Three patients had bilateral symptoms to address. One of the patients had been referred for ulnar nerve assessment prior to removing a bony mass of the medial epicondyle; this patient did not have any ulnar nerve symptoms. The clinical symptoms and signs of 19 upper limbs of 16 of the patients were highly suggestive of ulnar nerve lesion. The clinical symptoms and signs highly suggestive of FUN were considered to be paraesthesia and numbness of Digits 5 and 4 and the contiguous area of the hand, with clinically documented reduced pin prick sensation in the numb area only with or without motor signs or symptoms. Five of the remaining patients had reported to the referring physicians on direct questioning and in relation to various clinical problems, transient pain or tingling in their upper limbs radiating down to digit 5 (D5): none of these cases had any numbness, weakness or an abnormal sign. Five other patients had only transient pins and needles in D5: none of these patients had any numbness, weakness or any abnormal sign. Of the three remaining, the patient with bony swelling over the medial epicondyle had carpal tunnel syndrome (CTS) symptoms; the other two patients had unresolved previously diagnosed and decompressed CTS and had reported tingling in the digits 5 and 4 more than the rest of the hand. For the purposes of this study, we classified on clinical grounds the 16 patients with 19 symptomatic hands as FUN cases and the remaining 13 patients as not focal ulnar neuropathy (NFUN) cases. Depending on the history of onset of symptoms and its progression the FUN cases were further classified as acute FUN, and chronic FUN [1]. We classified the NFUN cases into five cases of paraesthesia of D5, 3 CTS cases and 5 as neurologically normal cases.

### **Control**

For the purposes of this study 30 healthy volunteers from hospital staff were recruited to obtain Dlat index reference values.

## **Neurophysiology**

All nerve conduction parameters were recorded using Teca disposable self-adhering gelled surface electrodes with the recording surfaces of 12 mm by 12 mm. For antidromic digital nerve sensory nerve action potential (SNAP) recording self-adhering gelled ring electrode strips were used. Nerves were stimulated using surface electrodes. Medelec-Synergy system was used in studying the patients and the controls. Whenever patients or controls had the skin temperature of the dorsum of their hands below 32° Celsius, their limbs were warmed up by immersing their hands to mid forearm in warm water for about 10 minutes. Through out recording hand temperature was monitored using the skin surface temperature probe of the Medelec-Synergy system. In every subject the skin temperature was maintained above 32° Celsius by a combination of maintaining the room temperature at about 22°-24° Celsius and by having the limb on hot water bottles during electrophysiological examination.

The median and ulnar MNAPs were recorded from the same electrodes placed 10 cm proximal to medial epicondyle with the elbow flexed to 45-90 degrees from full extension. The distance between the recording and the reference electrodes was 3 cm. Supramaximal stimuli were applied independently to the median and the ulnar nerves at the proximal crease of the wrist. Minimum averaging was required to record clean evoked MNAP. The conduction times were measured to the first negative deflection of the MNAP. The amplitudes of the MNAP were measured from base of the negative deflection to its peak. The difference of the latency between the two nerves was calculated by subtracting the median from the ulnar nerve latency.

The recommended standard electrophysiological assessment of each patient [2] started with studying the ulnar nerve segmental motor conduction parameters, followed by orthodromic sensory nerve conduction parameters of D5 to wrist segment. In all cases with normal orthodromic SNAP amplitudes, we recorded antidromic segmental sensory nerve conduction parameters including elbow segment. In cases with borderline elbow segment MCV we studied motor nerve conduction parameters across the elbow using 2cm- inching technique. To define the severity of any ulnar nerve lesion and to exclude other peripheral nerve lesions concentric needle electromyography was performed as per the need of the individual patient. All patients had median nerve motor and sensory conduction studies and superficial radial sensory conduction studies; and as need be the medial cutaneous nerve of forearm parameters were studied.

All individual nerve conduction values, obtained using standard electrophysiological tests, were deemed abnormal when their values were outside the normal limits of the reference values of the department. We have acquired these reference values from a local population of healthy volunteers for the routine diagnostic use of our department as per recommended standards [2].

Depending on whether the patient had motor and or sensory and or needle EMG abnormalities, the ulnar nerve electrophysiological findings were graded for the purposes of this study into the following six grades: - Grade 0 indicates absence of any detectable abnormality. Grade 1 represents presence of either motor or sensory conduction abnormality across the elbow segment. Grade 2 represents abnormality in both motor and sensory conduction parameters. Grade 3 indicates motor conduction abnormality and absent ulnar SNAP. Grade 4 would be defined in presence of grade 1,2 or 3 and concentric needle EMG abnormality; Grade 5 is defined by the presence of needle EMG evidence of severe denervation and reduced CMAP.

To test the distribution of the Dlat index obtained from the control population against a Gaussian distribution, we used Kolmogorov-Smirnov test.

## **Results**

### **Reference population**

The Dlat index in the control population had a mean value of 0.61 ms and standard deviation of 0.2 ms. Kolmogorov-Smirnov test showed that the Dlat index did not significantly deviate from a normal distribution (P value of the null hypothesis was greater than 1.0). Thus we defined the upper limit of Dlat index as mean + 3SD, giving a reference limit of normality of 1.23 ms. To err on side of caution we considered 1.3 ms as our upper limit of reference value.

### **Patients ( Table2)**

In all of the 19 upper limbs of the patients clinically classified as FUN, standard electrophysiological testing showed evidence of abnormality at the level of the elbow. Of the 8 nerves with acute FUN, half had Grade 4 abnormality the other half Grade 2 abnormality. Six of the nerves had abnormal above- elbow to below- elbow CMAP ratio. All of the 8 cases had significant slowing of CV across the elbow.

Of the chronic FUN cases all had abnormal CV across the elbow but none had evidence of abnormality in the above to below elbow CMAP amplitude ratio. Five nerves had Grade 2 abnormality, 4 had Grade 3 abnormality, 1 had Grade 4 and 1 had grade 5 abnormality. Three of the NFUN patients had focal abnormality of Grade 1; this was in form of only abnormal motor conduction velocity (MCV) across the elbow. One of these cases was a neurologically normal case and the other two were paraesthesia of D5 cases. The patient with epicondyle mass and CTS symptoms and no ulnar nerve symptoms had Grade 2 abnormality.

We did not attempt at recording mixed nerve action potential in one patient as the nerve was severely damaged. The Dlat index in four of the nerves with electrophysiological and clinical evidence of FUN had values less

than 1 ms; in four of the FUNN cases ulnar nerves MNAP had zero value. In these cases we used the absolute value of the median nerve MNAPs as the Dlat index value. Of the three NFUN cases with Grade 1 electrophysiological abnormality, one had a Dlat index value of 1.2 ms and the other two had values above 1.2 ms. All the cases with normal electrophysiology on standard testing had values less than 1.0 ms.

## **Discussion**

We found that Dlat index to be an easy parameter to record and not time consuming. In our cases, four patients with electrophysiological and clinical evidence of FUN had Dlat index values within normal limits. Four cases had on standard testing evidence of sub-clinical FUN [8]. In these 4 cases with sub-clinical FUN, one case had normal Dlat index. In 3 cases with electrophysiological and clinical evidence of FUN, ulnar nerve MNAP was not recordable. In these cases, if standard testing had not shown relative conduction abnormality across the elbow, Dlat index would have not been of any use in localization of the pathology. I am not sure why the Dlat index should have stayed normal when both the motor and sensory nerve fibers were abnormal across the elbow. Aberrant pathways might contribute to a normal Dlat index in face of clear abnormality on standard testing, but in our cases none had evidence of Martin-Gruber anomaly. The masking of a small delay across a few millimeters short segment that is inherent in the studying of a long segment might lead to normal Dlat index when there is clear focal abnormality on a battery of other tests. Unlike Merlvende et al none of our patients with normal standard tests had an abnormal Dlat index.

We conclude that in Dlat index is not as sensitive in detecting ulnar neuropathy as the established battery of motor and sensory conduction studies. Like standard motor and sensory conduction studies, this measurement detected sub-clinical abnormality. Therefore its relative insensitivity did not make this new measurement more specific and therefore clinically more relevant. Both the standard nerve conduction parameters and Dlat index detected sub-clinical pathophysiology in our study and in Mervlende et al work [7]. Therefore one can reiterate that the diagnosis of FUN should be and would be only reached after a thorough clinical examination and a detailed electrophysiological assessment of the motor and sensory parameters of the ulnar nerve [9]. There is no easy short cut to the diagnosis of symptomatic focal ulnar entrapment neuropathies be it acute or chronic in nature.

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## Tables

Table 1: Summary of salient clinical characteristics of patients

Case*	Sex	Age	Duration of the onset of the history	Clinical diagnosis†
4	F	34	1 month	Acute FUN
5	M	38	2 month	Acute FUN
6	M	26	4 month	Acute FUN
7	M	29	3 month	Acute FUN
19	M	26	3 month	Acute FUN
22	M	47	3 month	Acute FUN
29	M	60	1 month	Acute FUN
2	M	38	24 month	Acute FUN
3	F	45	18 month	Chronic FUN
8R	M	65	2 month	Chronic FUN
8L	M	65	6 month	Chronic FUN
14	F	54	Years	Chronic FUN
20	M	64	12 month	Chronic FUN
21	M	50	Years	Chronic FUN
23	F	34	6 month	Chronic FUN
26R	M	57	8 month	Chronic FUN
26L	M	57	8 month	Chronic FUN
27R	M	60	24 month	Chronic FUN
27L	M	60	24 month	Chronic FUN
1	F	64	6 month	Neurological normal
24	F	39	15 months	d5 paraesthesia
25	M	44	24 month	d5 paraesthesia
11	M	44	12 month	Carpal tunnel syndrome
28	M	47	60 month	Carpal tunnel syndrome
9	F	43	24 month	Neurological normal
10	F	36	10 month	Carpal tunnel syndrome
12	M	52	60 month	Neurological normal
13	M	62	24 month	Neurological normal
15	F	41	6 month	d5 paraesthesia
16	M	50	12 month	d5 paraesthesia
17	F	55	12 month	d5 paraesthesia
18	F	52	12 month	Neurological normal

\* R and L identify the 3 patients with bilateral symptoms

† FUN; focal ulnar neuropathy, d5 paraesthesia; only transients pins and needles in digit 5 with no abnormal sign, Neurological normal; patient with no neurologically specific symptoms and no abnormal signs, Carpal tunnel syndrome; patient with transient pins and needles in fingers and hand present on waking up from sleep and disappearing on movement

Table 2: Summary of electroclinical diagnosis and the salient neurophysiological findings.

Case	NP Grade *	Elbow/ Forearm MCV ratio †	Elbow/ Forearm SCV ratio †	Above/Below elbow CMAP ratio ‡	Electroclinical Diagnosis §	Dlat Index ¶
4	2	0.63	0	0.34	Acute FUN	4.4¶¶
5	4	0.69	Hand segment SCV only	0.70	Acute FUN	0.00
6	2	0.68	0.74	0.90	Acute FUN	1.45
7	4	0.52	0/0	0.49	Acute FUN	1.7
19	2	0.72	0.75	0.78	Acute FUN	0.9
22	4	0.66	0/0	0.22	Acute FUN	4.8¶¶
29	4	0.37	0/69	0.05	Acute FUN	4.7¶¶
2	2	0.80	0.75	0.92	Acute FUN	1.7
3	2	0.68	0.69	0.87	Chronic FUN	1.9
8R	4	0.77	Hand segment SCV only	0.86	Chronic FUN	2
8L	5	0.60	0/0	0.86	Chronic FUN	Not recorded #
14	3	0.62	0/0	1.00	Chronic FUN	2
20	3	0.55	0/0	0.81	Chronic FUN	2.4
21	3	0.80	0/0	0.96	Chronic FUN	1.5
23	2	0.91	0.80	0.91	Chronic FUN	0.7
26R	3	0.82	0/0	0.83	Chronic FUN	0.2
26L	5	0.78	0/0	1.00	Chronic FUN	5.0¶¶
27R	2	0.72	0.68	0.97	Chronic FUN	2.7
27L	2	0.65	0.67	0.95	Chronic FUN	2.1
1	1	0.82	1.10	0.84	Sub-clinical FUN / Neurological normal	1.5
24	1	0.75	Hand segment SCV only	1.00	Sub-clinical FUN / d5 paraesthesia	1.6
25	1	0.62	1.04	0.94	Sub-clinical FUN / d5 paraesthesia	1.2
11	2	0.63	0.78	0.90	Sub-clinical FUN / Carpal tunnel syndrome	2.3
28	0	0.89	1.08	1.00	Carpal tunnel syndrome	0.6
9	0	0.96	Hand segment SCV only	0.96	Neurological normal	0.1
10	0	1.06	1.13	0.93	Carpal tunnel syndrome	-0.2
12	0	0.83	0.98	0.97	Neurological normal	0.8
13	0	1.02	Hand segment SCV only	1.00	Neurological normal	0.2
15	0	1.07	Hand segment SCV only	0.96	d5 paraesthesia	0.6
16	0	0.98	1.01	0.98	d5 paraesthesia	0.3
17	0	1.00	0.97	0.96	d5 paraesthesia	0.9
18	0	1.11	0.99	0.95	Neurological normal	0.6

\* The Grade of neurophysiological findings. 0; normal, 1; either motor or sensory conduction abnormality, 2; motor and sensory conduction abnormality, 3; motor conduction abnormality and SNAP not recordable, 4; focal conduction abnormality and needle EMG abnormality, 5; focal conduction abnormality and severe needle EMG abnormality and reduced CMAP amplitude

† MCV; motor conduction velocity, SCV; Sensory conduction velocity,

‡ CMAP; compound muscle action potential

§ Electroclinical diagnosis; a definite diagnosis that is built on electrophysiological findings that would explain a patient's characteristic clinical history.

¶ These values are absolute latencies of the median nerve mixed nerve action potential as the ulnar mixed nerve action potentials could not be recorded.

# The mixed nerve action potential was not recorded as the ulnar nerve was severely damaged.