RELATIONSHIP BETWEEN THE ABSENCE OF SENSORY ACTION POTENTIAL AND DELAY OF DISTAL MOTOR LATENCY OF THE MEDIAN NERVE IN CARPAL TUNNEL SYNDROME. A RECEIVER-OPERATING CHARACTERISTIC CURVE ANALYSIS

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BACKGROUND

Usually in carpal tunnel syndrome (CTS) there is inverse relation between distal motor latency (DML) to abductor pollicis brevis muscle and distal sensory conduction velocity (SCV) of the median nerve with a few exceptions [1]. Based on this observation two similar electrophysiological severity scales were proposed [2,3]. These scales are largely used in literature; they assign severity stages on the basis of normality/delay of SCV and DML and presence/absence of sensory action potential (SAP) and compound muscle action potential (CMAP) of the median nerve. In both scales the absence of SAP was considered the electrophysiological findings to separate the moderate from severe forms of CTS. DML values at which SAP was almost always absent is different in literature.

AIM OF THE STUDY

The main aim of this study was to calculate DML cut-off value at which SAP was absent in CTS using ROC curves. The clinical utility of the knowledge of this value is discussed. For this purpose we reviewed the database of a previous study conducted for another aim [4].

METHODS

We consecutively enrolled 244 idiopathic CTS cases (mean age 56.8 years, females 70.9%) and 108 controls (mean age 52.4 years, females 69.4%) in an outpatients EMG lab. The diagnosis of CTS was based on clinical and electrophysiological findings. The controls had no symptoms of neuromuscular diseases nor systemic diseases and showed normal median nerve neurography. SAP of the median nerve was orthodromically measured in the third digit-wrist (M3) and in fourth digit-wrist (M4) tracts. SAP was considered absent if the traces averaged up to 50 stimuli and less than 0.1 microvolt were not detectable after two recording trials.

Statistical methods

Differences between CTS cases with and without median SAP were calculated with non-parametric Mann-Whitney and chi square tests. ROC curves and areas under ROC curves, sensitivity, specificity, likelihood ratio (LR) and predictive values (PV) of DML if M3/M4SAP was absent were calculated. We considered optimal cut-offs the values for which sensitivity and specificity were crossing. Linear regression analysis was used to evaluate correlations between DML and SCV (dependent variables: DML, independent variable: M3 SCV). The linear model was chosen because it explained at best the relation between the dependent variable and the regressor compared to non-linear model. Multivariate logistic regression was carried out to evaluate the risk factors associated to SAP absence of the median nerve in CTS patients. All P values < 0.05 were considered to be statistically significant.

DISCUSSION

It is well known that in CTS median DML delay is related to the delay of SCV and reduction of SAP amplitude until eventually SAP amplitude becomes so small that it becomes undistinguishable from the noise (i.e. for practical purposes it is considered absent).

The cut-off values of DML at which SAP is unrecordable were 6.25 and 7.68 ms in two previous papers, these values are higher than ours [2,3]. The difference may depend by different techniques of SAP recording (especially in which segment the SAP is measured), by different criteria of patients and controls enrollment and different race of the patients.

We prefer to use M3 and M4 SAP measurements in routine electrophysiological study. The absence of M4 SAP has the lowest DML cut-off in respect to the other SAP obtained stimulating the others digits because the sensory fibers from the fourth digit are more frequently damaged due to position in the carpal canal.

The DML cut-off may vary due to the electrophysiological methods and the threshold of SAP amplitude fixed to consider SAP absent. In our study, if we consider as threshold 0.1 microV, the number of patients who showed the absence of M3 and M4 SAP were 37 and 63, respectively, but these numbers rise to 53 and 95 if the threshold is fixed at 1 microV. In this last case the cut-off of DML decreases, but the diagnostic accuracy values slightly changes.

CONCLUSIONS

The knowledge of the cut-off of DML at which the SAP is considered absent may have some utilities:

1) This cut-off may be useful to separate the moderate group of CTS severity scale into two subgroups, if the sample size of CTS is very large and if it is necessary to stratify the "moderate" stage. Taking into account the results of diagnostic accuracy, M4 SAP alone should be used in the severity scale score.

2) During the electrophysiological examination of suspected case of CTS, if SCV value is quite far from that expected in relation to the value of DML, especially if DML is very delayed and SAP is still evoked, it is possible that the patient may suffer from a different disorder from CTS. However, we always remember that a possible lack of homogeneity in the results between SCV and DML of the median nerve in CTS may result from non-homogeneous damage or intraneural topography of the fibers of the median nerve in the carpal canal, anatomic variations of the course of the recurrent motor branch supplied the thenar muscles and presence of mononeuropathy of motor branch of the median nerve [5-10].

3) To identify the presence of real CTS in patients with sensory-motor polyneuropathy especially in the diabetics if the clinical findings are not sufficiently useful or uncertain. In this regard specifically-designed studies are needed.

References

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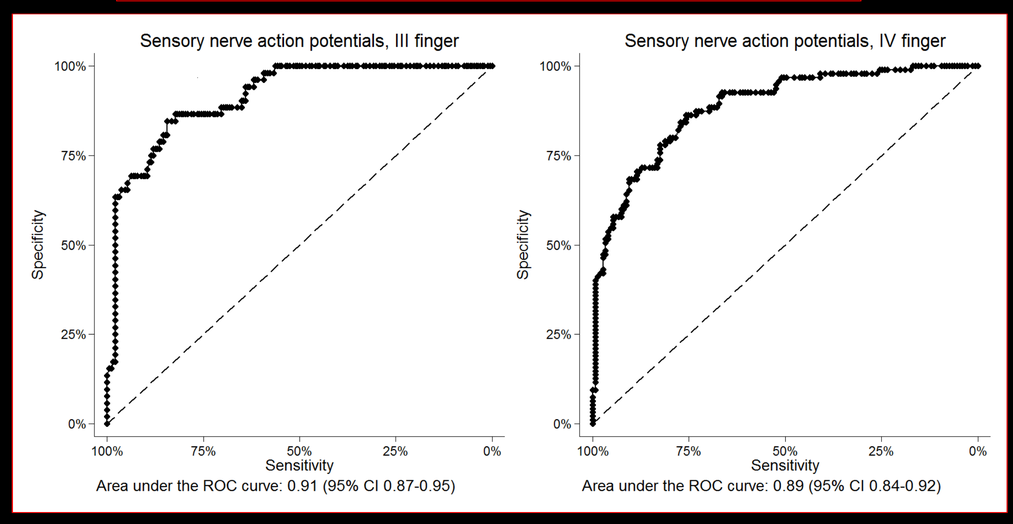
RESULTS

CTS patients with absence of only M4 and both M4 and M3 SAPs were 63 and 37, respectively. The cases with at least unrecordable M4 SAP were older, showed higher BMI and more abnormal motor neurographic parameters than cases with evocable M3 and M4 SAP.

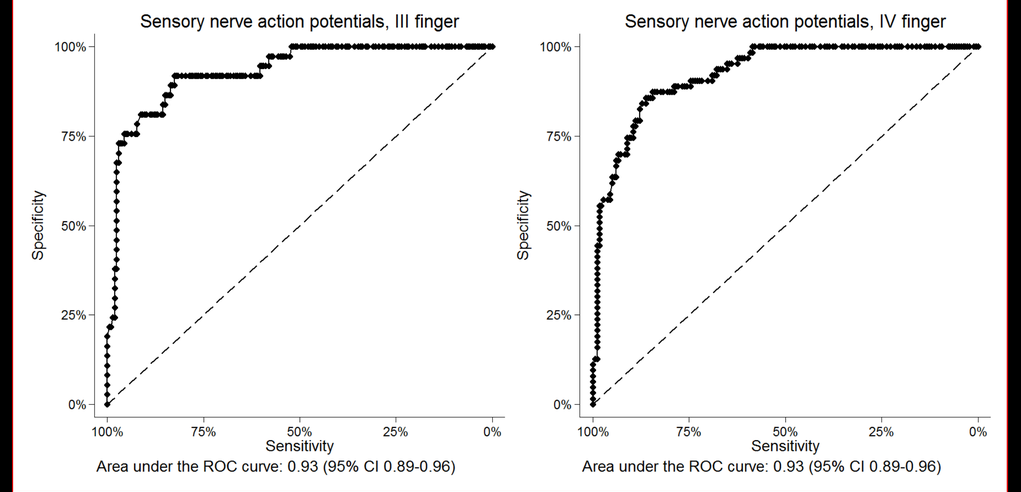
DML demonstrated to be sufficiently accurate to identify CTS cases with unrecordable M3/M4 SAP. The largest areas under ROC curves were 0.93 and had high accuracy (see figures). The optimal cut-off values to identify CTS patients with unrecordable M3 and M4 SAP were 5.95 and 5.83 ms, respectively. The diagnostic accuracy values for these thresholds are shown in the Table. Because LR+ was between 5 and 10 and LR between – 0.1 and 0.2, DML cut-off had discrete change in the probability that SAP was absent/present and also PV was sufficiently high (but we did not calculate PV taking into account the prevalence of CTS).

The logistic regression demonstrated that M4 SAP absence could be predicted only by DML (O.R. 3.7 95%CI 2.25-6.08).

Threshold of amplitude for considering SAP absent=1 microV



Threshold amplitude for considering SAP absent=0.1 microV



SAP variable e DML cut-off point	Sensitivity	Specificity	Positive Likelihood ratio	Negative Likelihood ratio	Positive predictive values	Negative predictive values
M3+M4 SAP absence (no.37), DML cut-off=5.95	91.9% (78.1-98.3)	82.6% (76.7-87.5)	5.28 (3.87-7.22)	0.1 (0.03-0.29)	48.6% (36.4-60.8)	98.3% (95-99.6)
M4 SAP absence (no.63), DML cut-off=5.83	85.7% (74.6-93.3)	86.2% (80.3-90.9)	6.21 (4.25-9.05)	0.17 (0.09-0.3)	68.4% (56.9-78.4)	94.5% (89.9-97.5)

REGRESSION EQUATIONS

M3 VCS = -6.62*DML + 72.72 (R2=0.65)

M4 VCS = -6.69*DML + 68.97 (R2=0.57)