

Short Report

Ratio between the amplitude of sensory evoked potentials at the wrist in both hands of left-handed subjects

A CRUZ MARTÍNEZ, M C PÉREZ CONDE, F DEL CAMPO, P MINGO AND M T FERRER.

From the Sección de Electromiografía, Servicio de Neurofisiología Clínica, Ciudad Sanitaria La Paz, Madrid

SUMMARY Maximum sensory conduction velocity, duration and amplitude of the sensory evoked potentials at the wrist on stimulating digits 1, 2, 3 and 5, were determined bilaterally in 21 left-handed subjects with an age range from 6 to 47 years. The amplitude of the sensory evoked potential at the wrist was larger in the right hand. This asymmetry is the reverse of the one previously observed in right-handed infants and adults. It could be physiological and suggests a difference in density of sensory innervation between the two hands. Asymmetry of sensory innervation can be helpful in the study of hand dominance.

In the study of the ratio between the amplitude of sensory evoked potential (SEP) at the wrist on stimulating different fingers, it had been concluded¹ that the larger amplitude corresponds to digit 1 and the smallest to digit 5. The ratio between the amplitude of different fingers varies according to the age of the subject.¹⁻⁵ Variations in the normal amplitude ratio can be applied to the topographic diagnosis of postganglionic radicular and brachial plexus avulsions, if a fixed segmental sensory innervation of the hand is previously accepted.⁶⁻⁸

In right-handed infants^{3,5} and adults^{1,9} the amplitude of the SEP was larger in the left hand than in the right one. These results suggest an asymmetry of sensory innervation of the hands which could be physiological. In this paper we determine the ratio between the amplitude of the SEP at the wrist on stimulating different fingers, and compare the amplitude of the SEP between both hands in healthy left-handed subjects.

Subjects and method

Twenty-one healthy left-handed subjects, 9 women and 12 men, whose ages ranged from 6 to 47 years,

with a mean age of 21·8 years, were studied. Left-handed suppressed cases were not included in this study. None of the subjects had signs or symptoms of neuromuscular disease. Right hemisphere dominance was confirmed.

The maximum sensory conduction velocity (SCV) from digit to wrist segment, and amplitude and duration of the SEP at the wrist were bilaterally studied stimulating digits 1, 2, 3 and 5. The ratio between the amplitudes of the SEP 2:1, 3:1, 5:1, 5:2 and 5:3 was determined in both hands. Amplitudes of the SEP in both hands were compared.

The details about stimulating and recording technique are described in previous papers.^{4,10}

Results

The first digit had the largest amplitude, followed by digits 3, 2 and 5. (Table and figure.) The ratio between the amplitude of the different fingers is similar in both hands, and also similar to the values previously calculated in right-handed subjects.

The maximum SCV, and duration and amplitude of the SEP were compared in both hands. In most of the left-handed subjects of this series, the amplitude of the SEP was larger in the right hand.

Statistical differences of the mean values of the amplitude of the SEP in left-handed subjects was significant for digits 1 and 2 (Table).

Address for reprint requests: Dr A. Cruz Martínez, C/Sta. Casilda, 1, 6° E. Madrid(5), Spain.

Accepted 1 October 1979

Table Maximum SCV from digit to wrist, and amplitude and duration of the SEP at the wrist, stimulating digits 1, 2, 3 and 5 in both hands of 21 left-handed subjects. Mean \pm standard deviation. Statistical significance between means (*P*)

Digit	Parameter	Right	Left	<i>p</i>
1	SCV (m/sec.)	52.1 \pm 3.38	50.2 \pm 5.20	>0.10,
	Duration (ms)	1.00 \pm 0.115	1.015 \pm 0.113	>0.60
	Amplitude (μ V)	49.04 \pm 16.45	39.80 \pm 13.29	<0.05
2	SCV (m/sec.)	58.35 \pm 5.34	57.38 \pm 6.65	>0.60,
	Duration (ms)	1.14 \pm 0.146	1.18 \pm 0.184	>0.40
	Amplitude (μ V)	22.92 \pm 7.81	18.28 \pm 5.56	<0.05
3	SCV (m/sec.)	57.16 \pm 4.83	56.35 \pm 6.98	>0.70,
	Duration (ms)	1.06 \pm 0.111	1.05 \pm 0.131	>0.70,
	Amplitude (μ V)	25.97 \pm 10.66	21.83 \pm 6.96	>0.10,
5	SCV (m/sec.)	54.64 \pm 6.35	55.58 \pm 8.31	>0.70]
	Duration (ms)	1.07 \pm 0.117	1.05 \pm 0.113	>0.50
	Amplitude (μ V)	13.73 \pm 4.20	11.71 \pm 3.91	>0.10

In previously published papers,^{1,5} we have concluded that in right-handed infants and adults, the amplitude of the SEP was larger in the non-dominant hand. The figure summarises the different results in right-handed and left-handed individuals.

Whereas the amplitudes of the SEP were larger in the right hand, the maximum SCV from digit to wrist and the duration of the SEP at the wrist were similar in both hands, without showing any significant difference (Table).

Discussion

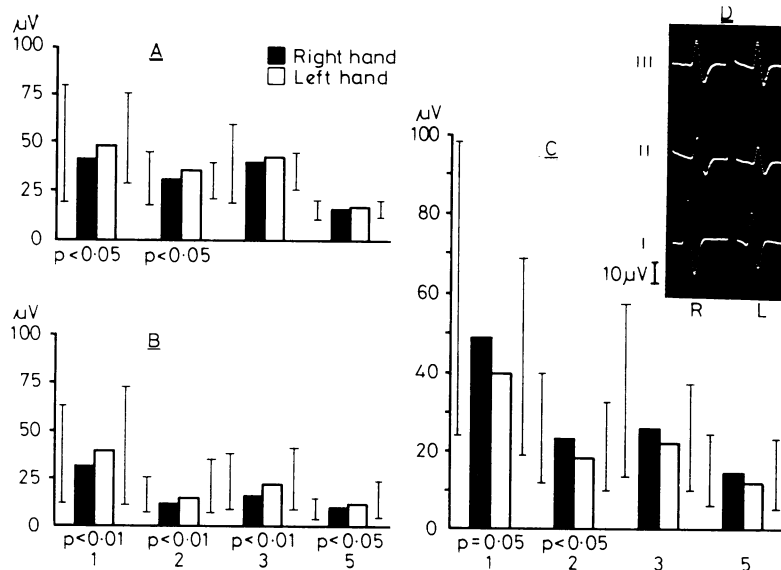
In another paper¹ the value of the ratio between the amplitude of the SEP at the wrist on stimulating different fingers, for a more precise topographic

location in radicular or brachial plexus is commented. So, we assume that the SEP amplitude is a function of the number of nerve fibres activated by electrical stimuli.¹¹ The amplitude of the SEP can thus indicate the density of the sensory innervation of each finger. In left-handed subjects the largest sensory innervation corresponds to digit 1, followed by digits 3, 2 and 5. The results are the same as those previously published in right-handed infants^{3,5} and adults^{1,9} and are in accordance with the cortical representation of each finger. Since the results are the same in infants as in adults, and in right- as in left-handed individuals, it is possible to conclude that the difference in amplitude of the SEP from the different fingers expresses the density of the sensory innervation for each finger, and that it is physiological.

Different studies in right-handed subjects have suggested that the density of the sensory innervation differs in both hands. The amplitude of the SEP is larger in the left hand of right-handed individuals. Differences of amplitude are more significant in adults⁹ than in infants.^{3,5} This asymmetry of sensory innervation can be well compared with the results in other papers^{12,13} where the discrimination of Braille configurations was better performed by the left hand of right-handed children and adults. Left hand superiority is only verified over 6¹⁴ or 10 years of age.¹³

In left-handed subjects we have now observed that the asymmetry of the amplitude of the SEP between both hands is the reverse of the one determined in right-handed individuals. The amplitude

A. Mean values of amplitude of SEP at the wrist of 30 right-handed subjects aged 5 months-9 years. B. In 44 right-handed adults aged 21-47 years. C. Amplitude in the hand in 21 left-handed subjects aged 6-47 years. Vertical lines expressed the range of amplitude for each finger. The data of (A) from Cruz Martinez et al.¹⁵ The data of (B) from Cruz Martinez et al.¹ D. SEP at the right (R) and left (L) wrist in a healthy left-handed adult aged 33 years. Bilateral stimulation of digits 1, 2 and 3.



of the SEP and, hence the density of sensory innervation, is larger in the right hand of left-handed subjects. As in previous publications, the maximum SCV from digit to wrist and the duration of the SEP at the wrist are not significantly different between both hands. The distances between stimulation and recording points, the circumference of the wrist (14.2 cms) and the temperature (33.0° C and 33.2° C) were the same in both hands as well. Thus, the variations due to the technique are not the explanation for the asymmetry of the amplitude of the SEP. Hence, this study in left-handed subjects can support the hypotheses¹ that the asymmetry of sensory innervation between the hands is physiological, but is reversed in right- and left-handed subjects.

We think that the results in right-handed individuals¹⁻⁵ and the conclusions of this paper provide a more precise information than the conventional electromyographic studies. If the amplitude of the SEP at the wrist is larger in the right hand, this parameter can be complementary data to determine that the subject is left-handed. More detailed studies might support this hypothesis.

References

- 1 Cruz Martínez A, Barrio M, Pérez Conde MC, Ferrer MT. Electrophysiological aspects of sensory conduction velocity in healthy adults. 2-Ratio between the amplitude of sensory evoked potentials at the wrist on stimulating different fingers in both hands. *J Neurol Neurosurg Psychiatry* 1978; **41**:1097-1101.
- 2 Dreschler F. Sensory action potentials of the median and ulnar nerves in aged persons. In: Kunze K, Desmedt, eds. *Studies on Neuromuscular diseases*. Basel: Karger, 1975; 232-5.
- 3 Cruz Martínez A, Ferrer MT, Bernacer M. Estudio de la amplitud de los potenciales sensitivos evocados de los nervios mediano y cubital en el niño. *Rehabilitación* 1975; **9**:169-82.
- 4 Cruz Martínez A, Pérez Conde MC, del Campo F, Barrio M, Gutiérrez AM, López E. Sensory and mixed conduction velocity in infancy and childhood. I-Normal parameters in median, ulnar and sural nerves. *Electromyogr Clin Neurophysio* 1978; **18**:487-504.
- 5 Cruz Martínez A, Pérez Conde MC, del Campo F, Barrio M, Gutiérrez AM, Ferrer MT. Sensory and mixed conduction velocity in infancy and childhood. II-Ratio between the amplitude of the sensory evoked potentials at the wrist, on stimulating different fingers in both hands. *Electromyogr Clin Neurophysio* 1978; **18**:505-15.
- 6 Sunderland S. Nerves and nerve injuries. Edinburgh and London: Churchill Livingstone; 1968.
- 7 Williams PL, Warwick R. Functional neuroanatomy of man. Edinburgh and London: Churchill Livingstone; 1975.
- 8 Inouye Y, Buchthal F. Segmental sensory innervation determined by potentials recorded from cervical spinal nerves. *Brain* 1977; **100**:731-48.
- 9 Monserrat L, Crespo F, Muntañola L, Jáuregui A. Estudio comparativo de los potenciales sensitivos por estimulación sucesiva de los cinco dedos de ambas manos. *Rehabilitación* 1974; **8**:257-72.
- 10 Cruz Martínez A, Barrio M, Pérez Conde MC, Gutiérrez AM. Electrophysiological aspects of sensory conduction velocity in healthy adults. I-Conduction velocity from digit to palm, from palm to wrist and across the elbow, as a function of age. *J Neurol Neurosurg Psychiatry* 1978; **41**:1092-6.
- 11 Buchthal F, Rosenfalck A. Evoked action potentials and conduction velocity in human sensory nerves. *Brain Res* 1966; **3**:1-122.
- 12 Rudel RG, Denckla MB, Spalten E. The functional asymmetry of Braille letter learning in normal, sighted children. *Neurology (Minnea)* 1974; **24**:733-8.
- 13 Rudel RG, Denckla MB, Hirsch S. The development of left-handed superiority for discriminating Braille configurations. *Neurology* 1977; **27**:160-4.
- 14 Witelson SF. Hemispheric specialization for linguistic and nonlinguistic tactual perception using a dichotomous stimulation technique. *Cortex* 1974; **10**:13-7.