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Temporal branch of facial nerve

A normative study of nerve conduction

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ABSTRACT

The temporal branch of the facial nerve is particularly vulnerable to traumatic injuries during surgical procedures. It may also be affected in clinical conditions. Electrodiagnostic studies may add additional information about the type and severity of injuries, thus allowing prognostic inferences. The objective of the present study was to develop and standardize an electrophysiological technique to specifically evaluate the temporal branch of the facial nerve. **Method:** Healthy volunteers (n=115) underwent stimulation of two points along the nerve trajectory, on both sides of the face. The stimulated points were distal (on the temple, over the temporal branch) and proximal (in retro-auricular region). Activities were recorded on the ipsilateral frontalis muscle. The following variables were studied: amplitude (A), distal motor latency (DML) and conduction velocity (NCV). **Results:** Differences between the sides were not significant. The proposed reference values were: A ≥0.4 mV, DML <3.9 ms and NCV ≥40 m/s. Variation between hemifaces should account for less than 60% for amplitudes and latency, and should be inferior to 20% for conduction velocity. **Conclusion:** These measurements are an adequate way for proposing normative values for the electrophysiological evaluation of the temporal branch.

Key words: electrodiagnosis, facial nerve, facial paralysis, neural conduction.

Ramo temporal do nervo facial: um estudo normativo da condução nervosa

RESUMO

O ramo temporal do nervo facial é particularmente vulnerável a lesões traumáticas nos procedimentos cirúrgicos. Também pode ser acometido em várias condições clínicas. Estudos eletrodiagnósticos podem acrescentar informações quanto ao tipo e severidade das lesões. A pesquisa visa aperfeiçoar técnica eletrofisiológica para avaliação específica daquele ramo. **Método:** Voluntários (n=115) foram submetidos a estimulação eletroneurográfica em dois pontos, nas duas hemifaces. Estímulo distal na têmpora, estímulo proximal na região retroauricular. Foram registradas distâncias dos pontos de estímulo até pontos anatômicos da face; assim como variáveis relacionadas com o potencial de ação resultante. **Resultados:** Houve grande variabilidade nas amplitudes, porém a diferença entre as hemifaces não foi significativa. Valores de referência propostos foram: amplitude (A) ≥0.4mV, latência motora distal (LMD) <3.9ms e velocidade de condução (VCN) ≥40m/s. Variabilidade aceitável entre os lados: LMD e A <60% e VCN <20%. **Conclusão:** Este estudo pode ser a ferramenta inicial para aplicações futuras no diagnóstico e seguimento de pacientes com lesões no ramo temporal.

Palavras-chave: eletrodiagnóstico, nervo facial, paralisia facial, condução nervosa.

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The facial nerve is responsible for muscle control of facial expression, as well as for the taste sensation on two thirds of the tongue[1]. Lesions to this nerve are mani-

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fested by difficulty or inability to wrinkle the forehead, close the eyes, smile, whistle or gargle. Depending on the site of injury, changes to taste sensation, salivation and hearing can also be observed[1].

The extracranial portion of the facial nerve starts at the emergence of the nerve at the stylomastoid, and the nerve path follows with subdivisions into terminal branches, towards the face midline[2-4]. The trajectory of the nerve and its branches has been widely studied, especially through cadaver dissection[2,5-7].

One of the subdivisions of the facial nerve is the temporal branch. It crosses the zygomatic arch obliquely, behind the angle of the zygomatic process of the frontal bone, approximately 2 cm anteriorly to the tragus and 1 cm from the frontal branch of the superficial temporal artery, closely related to the latter[2,5,8,9].

The temporal branch of the facial nerve is especially vulnerable to injury during surgical procedures with an incision in the temporoparietal area, e.g. neurosurgical craniotomy or cosmetic surgeries[9-12]. It may also be affected as poly or mononeuropathy in congenital, acquired, idiopathic or infectious clinical conditions[13-14].

The House-Brackmann scale is the most widely used clinical instrument for facial nerve functional evaluation[15-17]. Nerve conduction studies on the facial nerve provide important information regarding the type of lesion (axonal or demyelinating), as well as the severity of nerve injury, thus allowing prognostic inferences on functional recovery[18-20]. The usual electrophysiological evaluation of the facial nerve was mainly designed to evaluate peripheral facial paralysis, which usually results from nerve trunk involvement[21,22]. A number of studies evaluated patients with facial palsy with various different recording sites, including the frontalis muscle. These studies compared sites, but did not define absolute values for each of the variables[23]. A specifically designed technique for assessment of the temporal branch of facial nerve, including the definition of reference values, would be useful for evaluating injuries resulting from many clinical conditions and traumatic or postsurgical damage to this anatomical region.

The objective of this study was to develop and standardize an electrophysiological technique to specifically evaluate the temporal branch of the facial nerve.

METHOD

The selection of subjects was based on a questionnaire about health history and current complaints; evaluation of the facial muscles on the House-Brackmann scale and electrodiagnostic assessment of the tibial and sural nerves, in order to avoid possible subclinical neuropathies.

This study was approved by the Research Ethics Committee of Hospital das Clínicas, UFPE.

After signing an informed consent form, 115 subjects underwent facial electromyography (Racia Alvar®). The facial skin was cleaned with 70% alcohol and mildly abraded with Nuprep®. The recording electrodes (disposable, self-adhesive 3M® electrodes) were positioned on each side of the forehead, at the intersection point between two vertical lines passing through the pupil with the patient looking straight ahead, and a horizontal line, midway between the brow and the hairline (locations corresponding to the motor endplate areas of the frontal muscles).

The non-inverting (NI) electrode was ipsilateral to the stimulated side. An earth electrode was positioned below the chin. The forehead temperature was kept above 33ºC.

The facial nerve was stimulated with a standard bipolar stimulator in two points, one side of the face at a time: distal stimulus (DS) on the temporal branch, above the zygomatic arch; proximal stimulus (PS) in the nerve trunk, in the periauricular region, adjacent to the earlobe. In order to locate the optimal point of stimulation, the position of the cathode of the stimulator was changed until the maximal response was obtained with the lowest possible current intensity. The best stimulation sites were marked with a demographic pen. Recording was carried out using supramaximal stimulus.

The distances between PS and DS, and between DS and the non-inverting electrode were measured. The distances from DS to the palpebral fissure, DS to the tragus and lateral canthus of the eye to the tragus of the external ear, and the total head circumference, were also measured.

The parameters studied were the baseline-to-peak amplitudes of distal and proximal compounds of the muscle action potential, the distal motor latency and the conduction velocity. Data were expressed as central trend measurements (mean and median) and dispersion measurements (standard deviation and percentiles 5 and 95). For each variable, percentiles 5 and 95 for the difference between the hemifaces were also calculated and expressed as percentages. Based on the data, normative values for the parameters studied were proposed.

RESULTS

One hundred and fifteen healthy individuals were assessed. Their ages ranged from 20 to 68 years (mean=40, SD=12.6 years), and the group consisted of 48 males (42%) and 67 females (58%). Head circumference varied between 51 and 60 centimeters (mean=55.2, SD=1.80) and the distance between the lateral canthus of the eye and the tragus of the ear was 8.2±0.7 cm for both sides.

The mean distances from the distal stimulus to the non-inverting recording electrode, lateral canthus and tragus, were 4.8 (±0.6), 3.0 (±0.5) and 7.5 (±1.1), respectively. The mean distance between distal and proximal stimuli was 10 (±1.1).

Table 1. Mean and standard deviation for the electrophysiological parameters (n=115).

Parameter	Right side Mean (SD)	Left side Mean (SD)
DML (ms)	2.53 (0.66)	2.47 (0.60)
NCV (m/s)	50.98 (9.34)	50.31 (8.87)
DA (mV)	1.22 (0.59)	1.26 (0.58)
PA (mV)	0.98 (0.42)	1.02 (0.44)

SD: standard deviation, DML: distal motor latency, NCV: nerve conduction velocity, DA: distal amplitude, PA: proximal amplitude.

Table 3. Reference values for electrophysiological parameters and the acceptable difference between hemifaces, proposed for evaluation of the temporal branch of facial nerve, with registration in the frontal muscle.

	Absolute values	LR Difference (%)
DML (ms)	≤4.4	≤56.5%
NCV (m/s)	≥38.5	≤21.5%
DA (mV)	≥0.3	≤57.1%
PA (mV)	≥0.3	≤55.3%

DML: distal motor latency, NCV: nerve conduction velocity, DA: distal amplitude, PA: proximal amplitude.

Table 2. Electrophysiological parameters in percentiles (n=115).

	Right side			Left side		
Parameter	P5	P50	P95	P5	P50	P95
DML (ms)	1.7	2.3	3.9	1.7	2.3	3.6
NCV (m/s)	40.0	50.0	69.2	40.0	50.0	66.7
DA (mV)	0.4	1.1	2.2	0.5	1.2	2.4
PA (mV)	0.4	1.0	1.9	0.4	0.9	1.7

DML: distal motor latency, NCV: nerve conduction velocity, DA: distal amplitude, PA: proximal amplitude.

Table 1 shows the mean and standard deviation values of the neurophysiological parameters studied.

The paired t test showed no significant differences between the left and right side for distal motor latency (p=0.231), conduction velocities (p=0.252), distal amplitudes (p=0.394) or proximal amplitudes (p=0.178).

The normality test (Ryan-Joiner) was applied for each of the electrophysiological variables studied, assessing the right and left sides separately. The data did not follow a Gaussian distribution (p<0.01), and therefore the median and percentiles 5 and 95 of the variables were used (Table 2).

Based on these results, reference values for the absolute distal motor latency, nerve conduction velocity and amplitudes were proposed. Likewise, limits for the differences between sides were also proposed, as shown in Table 3.

Pearson's correlation test was applied to evaluate the relationship between head circumference and distal motor latency. There was no significant correlation, (r=0.024, p=0.803, for the left side; and r= –0.007, p=0.937, for the right side). There were significant but weak correlations between the subjects' ages and the distal amplitude (r= –0.209; p=0.025), distal motor latency (r= –0.209; p=0.025) and conduction velocity (r= –0.22; p=0.018).

DISCUSSION

The surgical dissection required in classical pterional dissections may damage the facial nerve in up to 30% of cases[24]. Esthetic procedures involving subcutaneous and submuscular dissection along the anterior temporal area can also damage the facial nerve and its branches in up to 2.5% of patients; a threatening consequence to face-lift surgery[2,25,26].

Over the years, surgeons have been improving techniques, searching for good exposure of the surgical surface with minimal retraction and preservation of nervous structures[4,8,11,27,28]. Anatomical knowledge of the temporoparietal region contributes towards safer surgical planning and maximal preservation of structures, including avoidance of nerve injuries during operative procedures.

EMG is a simple technique, with minimal risk to the patient and helpful in diagnosis, monitoring and prognostic evaluation of nerve injuries. The nerve trunk can be easily accessed, and is routinely evaluated in investigating acute and chronic neuropathies. However, specific evaluation of the temporal branch of the facial nerve is not routinely performed. The present study proposed definitions for normative values for the electrophysiological evaluation of that branch.

There were no significant differences between the right and left sides for any of the variables studied. A previous study with stimulation of the facial nerve in the retromandibular area near the stylomastoid and recording in the nasolabial sulcus showed the difference in amplitudes between the right and left sides in healthy subjects to be less than 3%[29].

There was great variability in the amplitudes obtained, ranging from 0.20 to 3.20 mV for the distal stimulus, and 0.20 to 2.7 mV for the proximal stimulus. This finding limits the use of absolute amplitudes, hence leading to the use of the difference between sides.

The present report is an initial effort towards development of a specific technique for evaluation of the temporal branch of the facial nerve. However, further studies are required. One topic of particular interest would be to study the variability between two subsequent recordings on the same subject. This could be very useful for recording data before and after the surgery. Possible nerve damages could then be assessed, using the same nerve as its own control.

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