Neurophysiologie Clinique/Clinical Neurophysiology (2013) 43, 189—195

Disponible en ligne sur SciVerse ScienceDirect www.sciencedirect.com

Elsevier Masson France EM|consulte www.em-consulte.com/en

ORIGINAL ARTICLE/ARTICLE ORIGINAL

Pneumatic evoked potential. Sensory or auditive potential?

Le potentiel évoqué pneumatique. Potentiel sensoriel ou auditif ?

S. Condé[a], C. Créac'h[a,c,d,e], X. Brun[b], R. Moreau[b], P. Convers[a,c,d,e], R. Peyron[a,c,d,e,*]

[a] *Department of Neurology, Neurophysiology and Pain Center, University Hospital, 42055 Saint-Étienne, France*
[b] *Laboratoire AMPERE, UMR CNRS 5005, université de Lyon, INSA Lyon, 69621 Villeurbanne cedex, France*
[c] *Central Integration of Pain, Neuroscience Research Center, U1028 Inserm, 42023 Saint-Étienne, France*
[d] *Université de Lyon, 42023 Saint-Étienne, France*
[e] *Jean-Monnet University, 42023 Saint-Étienne, France*

Received 10 May 2012; accepted 13 May 2013
Available online 29 May 2013

KEYWORDS
Pneumatic evoked potentials;
Methodology;
Somatosensory system;
Multimodal integration

Summary
Study aim. — In this study, evoked potentials (EPs) to a pneumatic, innocuous, and calibrated stimulation of the skin were recorded in 22 volunteers.
Methods. — Air-puff stimuli were delivered through a home-made device (INSA de Lyon, Laboratoire Ampère, CHU de Saint-Étienne, France) synchronized with an EEG recording (Micromed®).
Results. — A reproducible EP was recorded in 18 out of 22 subjects (82% of cases) with a mean latency of about 120—130 ms, and maximal amplitude at Cz. This EP actually consisted of two components, an auditory and a somatosensory one. Indeed, it was significantly decreased in amplitude, but did not disappear, when the noise generated by the air-puff was masked. We also verified that a stimulation close to the skin but not perceived by the subject was not associated with any EP. Conduction velocity between hand and shoulder was calculated around 25 m/s.
Conclusions. — This preliminary study demonstrates that pneumatic EPs can be recorded in normal volunteers.

MOTS CLÉS
Potentiels évoqués pneumatiques ;

Résumé
Buts de l'étude. — Dans cette étude, nous avons enregistré, chez 22 volontaires sains, le potentiel évoqué (PE) à une stimulation pneumatique calibrée délivrée sur la peau.
Méthodes. — Le stimulateur est un prototype qui permet de générer une sensation indolore de courant d'air sur la peau, synchronisé avec un appareil d'acquisition de PE (Micromed®).

* Corresponding author. Department of Neurology, Hopital Nord, CHU Saint-Étienne, avenue A.-Raimond, 42055 Saint-Étienne cedex 2, France. Tel.: +33 4 77 12 78 05; fax: +33 4 77 12 05 43.
E-mail address: roland.peyron@univ-st-etienne.fr (R. Peyron).

0987-7053/$ - see front matter © 2013 Published by Elsevier Masson SAS.
http://dx.doi.org/10.1016/j.neucli.2013.05.002

Somesthésie ;
Méthodologie ;
Intégration
multimodale

Résultats. — Cette stimulation pneumatique induit un PE somesthésique de latence moyenne de 120 à 130 ms, maximal sur l'électrode Cz et se distribuant à l'ensemble du scalp. Ce PE est obtenu de manière reproductible chez 18 sujets, soit dans 82 % des cas. Vu qu'il est significativement diminué d'amplitude mais ne disparaît pas lorsque l'on masque le bruit émis par le stimulateur, on en déduit qu'il est constitué de deux composantes, l'une auditive, l'autre somesthésique. On a pu valider qu'il était bien lié à la stimulation somesthésique car en stimulant à côté de la main, le potentiel disparaît. La vitesse de conduction mesurée entre deux sites, l'un proximal sur l'épaule, l'autre distal sur la main, est de l'ordre de 25 m/s.
Conclusions. — Il est possible d'enregistrer des potentiels évoqués pneumatiques par stimulation cutanée chez le sujet normal.

Introduction

Somatosensory evoked potentials (SEPs) have been traditionally and historically recorded through peripheral stimulation of large myelinated fibres by an electric current applied to nerve trunks, for example, the median or the ulnar nerve in the upper limbs [3—5,7]. Thermal or laser stimulators capable of generating painful sensations were developed to activate peripheral pain receptors and produce nociceptive EPs [2,13,14]. The capacity for pneumatic stimulations to produce an EP has been tested before, but only on rare occasions [9,10,12,15] and without any subsequent use in clinical practice. In this study, EPs were recorded with a prototype consisting of a compact pneumatic stimulator, which delivers a calibrated compressed air jet and produces a draught sensation on the skin. Considering that skin stimulation was systematically associated with an air propulsion noise, we wanted to ensure that the obtained responses did not only correspond to an auditory evoked response. By measuring the conduction velocity between two stimulation sites in 22 volunteers, we attempted to determine through which type of nerve fibres the recorded signals were transmitted.

Material and methods

Patients

Twenty-two healthy volunteers (12 women, 10 men, mean age: 22.8 ± 8.7 years, range 18 to 44) participated in this study. The only exclusion criteria were a history of psychiatric or neurological disease.

Stimulator

For this study, we developed a pneumatic stimulator, which includes a nozzle, an electropneumatic distributor placed in an adapted casing, and a pneumatic energy source with a pressure of 3.5 bars. The air outlet of the nozzle is 0.5 mm in diameter and delivers sterile pulsed air (less than 10 ms in duration), which is dispersed to produce a draught. Pulsed-air delivery produces a small noise of 45—55 dB. Stimulation frequency was 0.2 Hz with fixed inter-stimulus interval. The stimulator was placed perpendicularly to the skin at a minimum distance of 1 cm and a maximum one of 2 cm. All stimulations were applied on the right side, distally on the back of the hand (at equal distance between the base of the third finger and the wrist) and proximally on the shoulder (rise of the deltoid muscle).

Data acquisition

EPs were recorded with a cap including 19 active electrodes distributed over the scalp according to the International 10-20 EEG System. The reference electrode was placed on the nose and the ground one on Fpz. Electrode impedance (lower than 3 kΩ) was checked before starting acquisitions. The electrooculogram (EOG) was recorded with two electrodes placed at the external canthus of the left eye. Signals were acquired with a Micromed System Plus analysis system (band pass: 0.3—100 Hz; sampling frequency: 512 Hz; analysis time: 1 s; threshold for artifact rejection: 75 μV, in addition to manual rejection). Stimuli were triggered by the acquisition system via a TTL signal sent to the pneumatic stimulator. EP acquisition started at the moment of pulsed-air delivery.

Volunteers were comfortably lying in a quiet room with soft lighting. They were asked to relax. In order to rule out the possibility that responses would actually consist of a spurious contamination by an auditory EP generated by the intermittent noise of the stimulator, in half of these manipulations, we acoustically isolated the subject by making him/her listen to a white noise through an auditory helmet that totally masked the air jet noise.

Experimental paradigm

The study consisted of six series of 30 pneumatic stimulations (Fig. 1). Each series was recorded twice in order to ensure reproducibility. The six series corresponded to the following six experimental conditions:

- Condition A = proximal + auditory: pneumatic stimulations applied on the shoulder, no auditory masking;
- Condition B = proximal alone: pneumatic stimulations applied on the shoulder, auditory masking;
- Condition C = distal + auditory: pneumatic stimulations applied on the hand, no auditory masking;
- Condition D = distal alone: pneumatic stimulations applied on the hand, auditory masking;
- Condition E = auditory alone: air jet directed beside the hand, no auditory masking;