Epilepsy Research (2013) **106**, 318—325

journal homepage: www.elsevier.com/locate/epilepsyres

EEG characterization of audiogenic seizures in the hamster strain GASH:Sal

Melissa M. Carballosa-Gonzalez[a,b], Luis J. Muñoz[c], Tomás López-Alburquerque[a], José Manuel Pardal-Fernández[d], Eduardo Nava[e], Carlos de Cabo[d], Consuelo Sancho[a], Dolores E. López[a,f,*]

[a] *Instituto de Neurociencias de Castilla y León/IBSAL, C/ Pintor Fernando Gallego, n° 1, 37007 Salamanca, Spain*
[b] *The Miami Project to Cure Paralysis, University of Miami Miller School of Medicine, 1095 NW 14th Terrace, Room 2-34, Miami, FL 33136, USA*
[c] *Servicio de Experimentación Animal, Universidad de Salamanca, 37007 Salamanca, Spain*
[d] *Complejo Hospitalario Universitario de Albacete, c/ Hermanos Falcó, 37, 02006 Albacete, Spain*
[e] *Facultad de Medicina, Universidad de Castilla-La Mancha, c/ Almansa 14, 02006 Albacete, Spain*
[f] *Departamento de Biología Celular y Patología, Universidad de Salamanca, 37007 Salamanca, Spain*

Received 21 February 2013 ; received in revised form 27 June 2013; accepted 2 July 2013
Available online 31 July 2013

KEYWORDS
Electroencephalography;
Animal model of epilepsy;
Radiotelemetry recordings;
Video-EEG

Summary The study was performed to characterize GASH:SAL audiogenic seizures as true epileptic activity based on electroencephalographic markers acquired with a wireless implanted radiotelemetry system. We analyzed cortical EEG patterns synchronized with video recordings of convulsive behavior of the GASH:Sal hamster following an acoustic stimulus. All GASH:Sal presented archetypal motor symptoms comparable to current animal models of generalized tonic—clonic epilepsy. Seizures consisted of an initial bout of wild running, followed by opisthotonus, tonic—clonic convulsions, tonic limb extension, and terminated in postictal depression. EEG patterns correlated with behavior and displayed phase appropriate spike—wave complexes, low-amplitude desynchronized activity, and high frequency large-amplitude peaks. Our results confirm that electroencephalographic profiles of the audiogenic seizures of the hamster GASH:Sal are parallel to EEG patterns of other animal models of generalized tonic—clonic seizures. Therefore, this animal may serve as an appropriate model for epilepsy research.

* Corresponding author at: Laboratorio de Trastornos audiomotores, Instituto de Neurociencias de Castilla y León/IBSAL, Universidad de Salamanca, C/ Pintor Fernando Gallego, 1, 37007 Salamanca, Spain. Tel.: +34 294400; fax: +34 923294549.
E-mail address: lopezde@usal.es (D.E. López).

0920-1211/$ — see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.eplepsyres.2013.07.001

Introduction

Animal models of seizures and epilepsy are important tools for studying epileptic disorders, and provide valuable insights to its development and treatment (Sarkisian, 2001). Traditionally, studies of generalized epilepsies rely on animal models with chemical (e.g., biculline, γ-aminobutyric acid, kainic acid, N-methyl-D-aspartic acid; picrotoxin; reserpine) (Fisher, 1989; Gean and Shinnick-Gallagher, 1987; Zhou et al., 2006; De Deyn et al., 1992; Pretel Pretel et al., 1995; Williams et al., 2006; Yang et al., 2001) or electrical (Swinyard, 1972) evoked seizure activity, as well as genetically susceptible models (Kitami et al., 2004; Noda et al., 1998; Yagi et al., 2005); however, these current models are imperfect and may not be suitably analogous to the human condition.

An animal model demonstrating reflex generalized seizures would prove propitious given that their sensory triggered seizures parallel the idiopathic nature of the human disease. Therefore, seizures produced by specific sensory stimulation such as sound or light, in genetically susceptible animals may result better adaptable and appropriate to address the underlying pathophysiology of epilepsy (Ross and Coleman, 2000).

The genetic audiogenic seizure-susceptible hamster (GASH:Sal), a new strain of Syrian hamster inbred at the University of Salamanca, exhibits generalized convulsive audiogenic seizures (AGS) in response to intense acoustic stimulation (AS) (Muñoz et al., 2001; Muñoz De La Pascua and López, 2005; Prieto-Martin et al., 2012).

In the GASH:Sal, seizure profiles are characterized by a sequence of wild running which culminates in severe tonic–clonic convulsions, and recesses into a catatonic postictal depression (Muñoz De La Pascua and López, 2005). Although certain motor components of AGS (i.e., wild running), are not commonly present in human generalized tonic–clonic seizures (GTCS), we strongly believe this to be a reliable animal model of epilepsy as substantiated by electroencephalographic recordings (EEG) of a conspicuous progressive seizure profile similar to those exhibited by other models of inherited AGS susceptibility (Dailey et al., 1989; Faingold, 1988; Reigel et al., 1986) and those exhibited during human GTCS (Treiman et al., 1990a).

EEG patterns of GTCS in man have been well described (Roger et al., 1974; Treiman et al., 1990b; Theodore et al., 1994; Morin and Wood, 2001; Darcey and Williamson, 1985; Gotman et al., 1993; Lopes da Silva et al., 2003) and GTCS motor phenomena begin with a tonic phase of whole-body stiffening, followed by a myoclonic phase of repetitive contractions, which are interrupted by a period of unresponsiveness.

The goal of this study was to collect and assess synchronous motor and cortical activity during AGS episodes of the GASH:Sal hamster. We combined the use of an untethered radiotelemetry transmitter implanted in a subcutaneous pouch which gathers cortical EEG data along with video recordings to correlate motor behavior with electroencephalographic markers. Implantable radiotelemetry provides and advantage over tethered methods in that it allows data collected under the basal physiological conditions of the animal which suppresses artifact caused by movement, stress and handling.

Materials and methods

Animals and housing

For this study, two strains of Syrian hamsters (*Mesocricetus auratus*) were used: 4 (2–4 months old) control AURA hamsters (Harlan Ibérica, Barcelona, Spain) and 6 (2–3 months old) GASH:Sal hamsters originating in the Animal facility of the University of Salamanca, Spain.

The animals were handled according to the Spanish current legislation (RD 1201/05), and the recommendations of the European convention for the protection of vertebrate animals used for experimentation and other scientific means (2007/526/EC).

Telemetry system

The telemetry system used consists of a Teflon-coated telemetry implant (PhysioTel® transmitter TA10ETA-F20; Data Science International – DSI, Lexington, USA), RPC-1 receiver plates (DSI), which transmits telemetered data from the implant and forwards it to a data exchange matrix (DSI) which serves as a multiplexer as well as a computer installed with Dataquest™ A.R.T™ 4.1 (DSI) to acquire and analyze EEG recordings.

Transmitter implantation

Hamsters were anesthetized with ketamine (Imalgène 1000; Merial, Lyon, France, 40 mg/kg) and xylazine (Rompun®; BayerVital, Leverkusen, Germany, 7 mg/kg). Body hair was shaved from the medial canthus of the eyes, over the roof of the skull up to the interaural level, and across the neck and shoulders, and the skin swabbed with iodine. A midsagittal incision over the skull and down the neck was made. Using blunt-tip scissors, a subcutaneous tunnel leading from the neck to the flank was made by pushing aside connective tissue and irrigating with saline solution. The radiotelemetry transmitter was then placed and sutured in the pocket and the leads tunneled forward to the exposed skull.

The periosteum was cleaned using cotton swabs and treated with 10% H_2O_2 to remove any tissue from the skull and to allow fixation with acrylic resin (Meliodent, Bayer Dental, UK). Two burr holes, each approximately 0.8 mm in diameter were drilled with an electric high-speed dental drill 2.5 anterior and ±2.0 mm lateral to bregma on each hemisphere, as adapted from the hamster stereotaxic atlas by Morin and Wood (2001). The silicone insulation was removed from the end of two transmitter leads and the exposed steel wire was placed within each hole onto the dura mater of the primary motor cortex (M1) to allow bipolar recording of overall cortical activity.

Following placement, the electrodes were secured and fixed with dental acrylic (Meliodent, Bayer UK Ltd., Newbury, UK), and the scalp was closed with wound clips. Following surgery, the hamsters were housed in individual cages.