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EVALUATION OF DIFFUSE BLASTWAVE INDUCED BRAIN INJURY USING EEG

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Rapportens titel

Luftburen explosionsinducerad stötvåg; undersökning av eventuell hjärnpåverkan med EEG; preliminära resultat

Sammanfattning (högst 200 ord)

Electroecephalogram (EEG) kan ge värdefull information om den elektriska aktiviteten i hjärnans ytliga delar. EEG kan användas för som underlag för diagnos av fokala kramper, men även ge information om diffus påverkan av hjärnan. I denna studie har vi undersökt om EEG kan användas för att beskriva påverkan på nervsystemet efter explosionsutlöst stötvåg. Vuxna sövda råttor exponerades i en special byggd testtub för stötvågor från 1-3 gram PETN som bringades att detonera på ett avstånd av 1 meter från det sövda djuret. EEG, hjärtrytm och andningsaktivitet registrerades kontinuerligt från 5 minuter före explosionen till 30 minuter efter. Resultaten visar att detonationen medförde en säkning av såväl amplitud som frekvens av EEG. Effekterna stod i direkt relation till laddningens storlek. Det bedöms som troligt att effekterna är så stora att de skulle leda till en medvetande förändiring hos en icke sövd exponerad individ. Efter detonation av 2 och 3 grams laddning kvarstod effekter på EEG under hela observationstiden. En sänkning av hjärtfrekvens och upp till ca 30 sekunder lång apne (andningsuppehåll) efter detonationen kan ha bidragit till effekterna på EEG. Vi konkluderar att EEG bör vara envärdefull komponent i den kliniska utvärderingen av skador inducerade av detonation av explosivämnen.

Nyckelord

Vapentraumatologi, sårbarhet, tryckvågseffekter, verkansvärdering, skallskador, hjärnan

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Report title (In translation)

EVALUATION OF DIFFUSE BLASTWAVE INDUCED BRAIN INJURY USING EEG; PRELIMINARY DATA

Abstract (not more than 200 words)

Electroencephalograms (EEG) may provide detailed information about pathologic functional changes in the brain associated to focal lesions. Seizurogenic activity develops in many patients following focal brain injury and may be involved in the pathophysiological effects of brain trauma and stroke.Effects of diffuse traumatic brain injuries may be difficult to evaluate using histological examination or MRI. In this study we have examined the effects on the EEG of moderate air blast waves from explosions. A specially designed shock tube was used, in which anaesthetized rats were exposed to moderate air blast by the detonation of a charge consisting of the non-electric detonating cap with a 1 - 3 grams (g) PETN explosive at a distance of 1000 mm. In some experiments the effect of repeated detonation was studied. EEG was continously recorded for 30 minutes after the detonation using pediatric scalp electrodes. Animals subjected to a shock wave from 1 g PETN showed minimal or small EEG changes, whereas the detonation of 2 g PETN induced a significant decrease in EEG. This effect was even more profound after detonation of 3 g PETN or a repeated detonation at the 2 g level. No epileptiform or seizure activities were recorded in the exposed rats or in age-matched control rats. These data indicate that EEG may be an useful diagnostic tool for the evaluation of acute effects of diffuse brain injuries and show that the effects of airborne blastwaves are dose dependent with regards to EEG depression.

Keywords

weapon's traumatology, human vulnerability, shock wave effects, assessment of human effects, head injury

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EVALUATION OF DIFFUSE BLASTWAVE INDUCED BRAIN INJURY USING EEG; PRELIMINARY DATA

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INTRODUCTION

It has recently been reported that exposure to a airblast waves from explosives may induce severe changes in the brain. Employing a rat model for blast exposure, Säljö and coworkers reported that exposure in the range of 154 kPa/198 dB or 240 kPa/202 dB induced pronounced changes in the distrubution of neuronal cytoskeletal proteins (9). In addition, they observed activation of microglial cells (10) and induction of apoptosis (11). Furthermore, it has been reported that rats exposed to blast waves may have cognitive defects and memory impairment (4). Groups of patients injured by explosive munitions have been demonstrated to have a high proportion long-term neurologic disability and it has been suggested that a variety of effects on the central nervous system from blast injury could be responsible for some aspects of what has been considered as the posttraumatic stress disorder (3). There is an obvious need for non-invasive techniques to get a good correlation between animal data and clinical materials. In order to provide such information, we have started to reevaluate the model used by Säljö by magnetic resonance imaging (1) (MRI, reported separately), electroencephalograms (EEG) blood sampling for serologic examination of S-100 protein (5, 7, 8) supplemented by careful histological examination, in situ hybridisation and electron microscopy.

Electroencephalograms (EEG) may provide detailed information about pathologic functional changes in the brain associated with focal lesions. Seizurogenic activity develops in many patients following focal brain injury and may be involved in the pathophysiological effects of brain trauma and stroke.Effects of diffuse traumatic brain injuries may be difficult to evaluate using histological examination or MRI. In this study we have examined the effects on the EEG of moderate air blast waves from explosions.

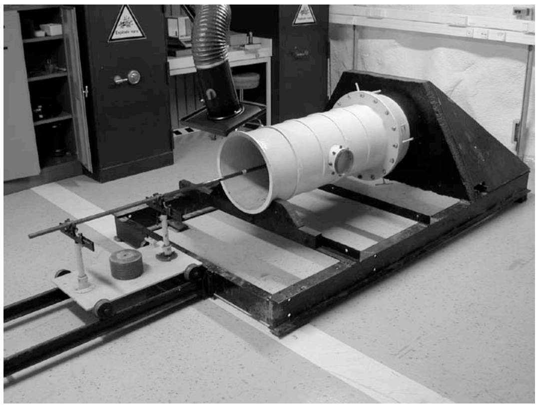

Fig. 1. The open shock tube

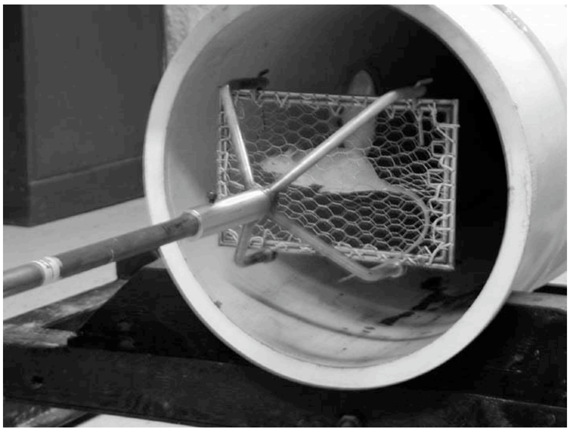

Fig. 2. The tire netting cage for fixation of rat during blast exposure

MATERIAL AND METHODS

Adult Sprague-Dawley rats were used (BK Universal, Stockholm Sweden), body weight 200 to 250 g, housed under standard conditions, lights on 07:00 am. and lights off 07:00 p.m., with free access to water and food pellets. All experiments were performed according to the ethical approval (Umeå Djurförsöksetiska nämnd A81-99).

A specially designed shock tube (Fig. 1 and 2) was used, in which anaesthetized rats were exposed to moderate air blast by the detonation of a charge consisting of the non-electric detonating cap with a 1 - 3 g PETN explosive at a distance of 1000 mm. This generated a shock wave with a duration of 1-2 ms. For the blast or sham exposure the rats were anaesthetized by an intra-peritoneal injection of chloral hydrate (300

– 360 mg/kg body weight) or a mixture of Hypnorm and Dormicum®. In some experiments the effect of repeated detonation was studied. EEG was continously recorded for 30 minutes after the detonation using pediatric scalp electrodes. The EEG was analyzed with regard to frequency, amplitude and focality. Heart rate and breathing movements were recorded throughout the experiment. After 30 minutes the rats were killed and the lungs and brain were examined visually for signs of bleeding.

RESULTS AND DISCUSSION

Animals subjected to a shock wave from 1 g PETN showed minimal or small EEG changes, whereas the detonation of 2 g PETN induced a significant decrease in both the amplitude and frequency of the EEG. This effect was even more profound after detonation of 3 g PETN or a repeated detonation at the 2 g level. Effects on the EEG were observed throughout the experiment in both 2 and 3g animals. No epileptiform or seizure activities were recorded in the exposed rats or in age-matched control rats.

All exposed animals showed a decrease in heart rate and an apnea with a duration of about 10 seconds in the 1g animals up to around 25 seconds in 2 and 3 g animals. In some of the animals which had been exposed to a 3 g detonation, bleedings in the lungs were observed.

It has previously been reported that high-energy missile trauma can elicit remote effects on the EEG (6). Moreover, Axelsson and co-workers have described similar changes in pigs exposed to a blast wave from a detonating high-explosive charge (2).

The results of the present study indicate that EEG may be an useful diagnostic tool for the evaluation of acute effects of diffuse brain injuries and show that the effects of airborne blastwaves are dose dependent with regards to EEG depression. However, the associated changes in heart rate and breathing shows that it is difficult to conclude if the observed EEG changes primarily is a effect on the central nervous system or secondary to vascular changes.

RECOMMENDATION:

It is suggested that the possibility to use EEG as a diagnostic tool in patients exposed to blast injury should receive more attention. A further evaluation of the employed animal model with digital EEG sampling is recommended.

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