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EXPERIMENTAL STUDY OF OCULOCARDIAC REFLEX (OCR) WITH GRADED STIMULI

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Abstract : The present study was conducted to observe the effect of graded mechanical stimuli on occurrence of oculocardiac reflex (OCR). The experiments were carried out in twenty albino rabbits of either sex weighing between 1–2 kg. Changes in heart rate and/or cardiac rhythm (oculocardiac reflex) were studied by applying traction with progressively increasing weights to medial rectus muscle. Mean threshold value of square wave mechanical stimulus just sufficient to produce oculocardiac reflex was found to be 19 ± 8.52 g. As the traction weights were progressively increased, more and more decrease in heart rate was observed. It was concluded that once the threshold value of stimulus was reached, the oculocardiac reflex showed a graded response with progressively increasing traction weights.

Key words : oculocardiac reflex (OCR) graded mechanical stimulus extra-ocular muscle graded response

INTRODUCTION

The oculocardiac reflex (OCR) is a trigemino-vagal reflex characterized by occurrence of bradycardia and/or other cardiac rhythm disturbances following manipulations on the eye and its surroundings especially after traction on extra-ocular muscles (1).

An abundant literature has accumulated in various journals regarding different aspects of OCR. It has been reported that bradycardia produced by manipulation of eyeball is directly proportional to the pressure applied (2, 3). Lang et al (4) have also stated that in addition to other factors, the risk of occurrence of OCR also depends upon the strength, duration and waveform of the stimulus. However, in the available literature, no study was observed which depicted the value of threshold stimulus just sufficient to elicit OCR and the effect of graded mechanical stimulation on OCR. Therefore, the present experimental work was planned to study these unidentified aspects of OCR.

METHODS

The experiments were carried out on 20 albino rabbits of either sex weighing between

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1 and 2 kg. The ethical committee and PG Board of studies of the institution duly approved the plan of study. Institutional guidelines for the care and use of laboratory animals were duly followed. Overnight fasting rabbits were anaesthetized with intravenous urethane (1.5 g/kg. body weight). Tracheostomy was performed for endotracheal intubation. The femoral vein on one side was exposed and cannulated for intermittent injection of anaesthetic agent. The electrocardiogram (ECG) was recorded on one channel of the four-channel recorder (Polyrite, INCO) by using needle electrodes. The femoral artery was also cannulated to record the blood pressure on another channel of Polyrite with the help of a pressure transducer.

Medial rectus (MR) muscle was dissected out by performing very gentle perilimbal peritomy. A silk suture was passed below the muscle and a loop was made. Another silk suture with wire hooks on both ends was passed over a pulley fixed on a stand. One hook was engaged in the silk suture loop under the muscle tendon and the other hook was used to attach weights for giving mechanical stimulus.

In each rabbit, after taking the basal recording of ECG and blood pressure, traction was applied to medial rectus muscle with a weight of 5 g by using a square wave (SW) type of stimulus (acute traction sustained for a period of 20 seconds followed by acute release) and heart rate during this period was noted. The procedure was repeated with 10 g weight and then in increments of 10 g until the response was obtained. Traction with these low weights was aimed at determining the threshold value just sufficient to produce a response. To look for the effect of graded stimulation, traction weight was increased from 50 g to 250 g in increments of 50 g. Pause of 5 minutes was given after muscle traction with each weight during which the muscle was free from any load. This was done to avoid the effect of fatigue on the oculocardiac reflex.

The OCR was considered to be positive whenever there was slowing of heart rate by more then ten percent and/or occurrence of arrhythmias during traction on extra-ocular muscles (5, 6, 7). Statistical analysis was performed by applying ANOVA and Pearson's coefficient of correlation using SPSS 10.

RESULTS

The Mean ± SD basal heart rate and arterial pressure (MAP) observed were 283 ± 25.8 beats/min and 85.45 ± 12.35 mmHg, respectively. None of the animals showed positive OCR with 5 g traction weight, which suggests that 5 g weight could be a sub threshold stimulus. The threshold value of square wave mechanical stimulus just sufficient to produce OCR ranged from 10–40 g in different animals studied and the mean threshold value was calculated to be 19 ± 8.52 g. The graphical recording of positive OCR obtained during medial rectus muscle traction is shown in Fig. 1. The mean ± SD and percentage decrease in heart rate on traction with increasing weights is shown in Table I. The percentage fall in heart rate observed was found to increase with progressively increasing traction weights and a significant correlation was found between change in heart rate and increase in traction weight (Fig. 2).

TABLE I: Mean ± SD and percentage decrease in heart rate on medial rectus muscle traction with increasing traction weights.

S. No.	*Traction weight*	*Basal*	*Mean heart rate (Beats/minute) During muscle traction*	*Decrease during traction*	*Percentage decrease in heart rate*
I	50 g	284.00±27.08	245.55±25.25	38.75±8.73	13.62%
II	100 g	288.00±26.62	246.35±22.86	41.65±12.07	14.46%
III	150 g	284.20±25.56	241.50±26.54	42.70±17.63	15.07%
IV	200 g	284.70±28.50	242.90±28.01	44.80±13.41	15.57%
V	250 g	284.05±25.78	232.50±22.62	51.55±21.65	18.14%

ANOVA F = 2.33995; P=0.06001

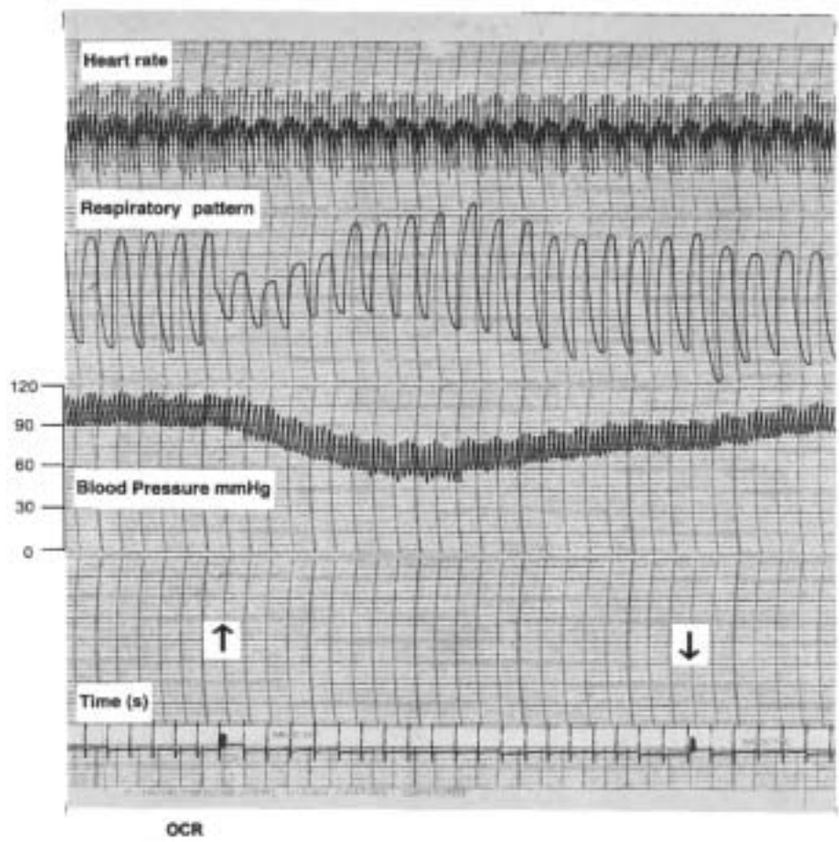

Fig. 1: Graphical recording of occurrence of oculocardic reflex (OCR) on medial rectus muscle traction. ↑-start of stimulus; ↓-end of stimulus.

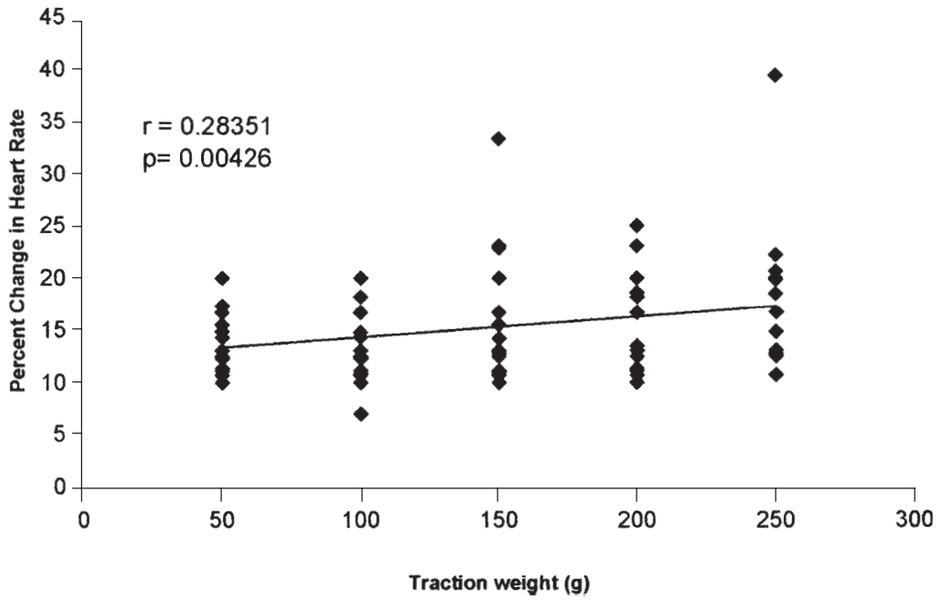

Fig. 2: Relationship between increase in traction weight and percent change in heart rate.

DISCUSSION

Oculocardiac reflex (OCR) is a common occurrence in ophthalmic surgery and has been extensively studied. In the present study, an attempt was made to determine the minimum amount of mechanical stimulus just sufficient to produce positive OCR in each animal and also, to observe the effect of graded mechanical stimulation on occurrence of OCR.

The oculocardiac reflex can be elicited by compression of the eyeball as well as traction of extra-ocular muscles. Further, reflex bradycardia can also occur during facial surgery not involving the orbit (4). However the type of stimulus used is considered to be an important determinant in the production of OCR and Blanc et al (8) have reported that square wave (Type A) stimulus, i.e., acute and sustained traction on extra-ocular muscle maintained for 20 sec followed by acute release is more reflexogenic. Therefore, we also used a square wave type of stimulus in our study. The value of threshold stimulus was found to range from 10 g to 40 g with a mean value of 19±8.52 g.

Further, it was noted that once the threshold value was reached, traction with progressively increasing traction weights lead to a progressive decrease in heart rate (Table I and Figure 2). Though the statistical analysis done by applying ANOVA showed no significant variation in heart rate among five loading states ($F = 2.33995$, $P = 0.06001$) but these observations do suggest that OCR showed a graded response. At the same time, a significant correlation was found between percent change in heart rate and increase in traction weight ($r = 0.283$, $P = 0.00426$) as shown in Fig. 2.

Our results corroborate the observations of other workers who reported that the

changes observed in heart rate during manual compression of the eyeball were proportional to the degree of pressure applied, i.e., bradycardia was more marked with increasing pressure and too much pressure even led to cardiac standstill (2, 3). Further Lang et al (4) also proposed that stimulus strength; duration and waveform were important determinants of severity of OCR. However, no study involved the use of measured graded stimuli to observe the effect on OCR as done in this study.

The graded response of oculocardiac reflex observed might possibly be due to the change in discharge rate of afferent nerve endings present in the extra-ocular muscles. Studies conducted on the afferent impulses from the extra-ocular muscles show that low threshold stretch receptors are present in the eye muscles of few laboratory animals including rabbits, which behave just like muscle spindles and are exquisitely sensitive to stretch. It has been further reported that, increasing degree of stretch produced rapid acceleration of impulses, i.e., the rate of discharge of impulses increases in a linear fashion (9, 10, 11). As a result, more and more impulses reached the brainstem. Therefore, it may be logical to speculate that this increased discharge rate of afferent nerve endings may reflexly lead to increased activity in the efferent arc of oculocardiac reflex producing progressively increasing bradycardia.

These observations could have clinical implication in human subjects. That is, these findings reinforce the importance of adjusting the degree of stretch or pressure to be given to ocular structures during ocular surgeries especially those involving manipulation of extra-ocular muscles such as strabismus surgery, enucleation operation and retinal detachment surgery.

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