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Effectiveness of vestibular adaptation versus controlled breathing exercises for motion sickness: Comparative study

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Abstract
Background: Motion sickness is also known as travel sickness, is a condition in which disagreement exists between visually percieved movement and vestibular system's sense of movement. Motion sickness is common problem in people travelling by bus, train, airplane, boat and especially cars. Vestibular adaptation and controlled breathing exercises are an alternative to drug therapies.
Objective: To compare the effect of vestibular adaptation versus controlled breathing exercises for motion sickness.
Materials and Methodology: Both males and females (n=30) from tertiary care hospitals in Miraj Taluka with age group of 18-30 years were included in this study. Participants were screened based on inclusion and exclusion criteria and were divided into Group A and Group B. Vestibular adaptation exercises were given to Group B and controlled breathing exercises were given to Group A participants for 5 days per week for 2 weeks for 15minute. Data collection was done by motion sickness assessment questionnaire (MSAQ).
Result: The results were found to be statistically significant within Group A and B with each of MSAQ components are gastrointestinal, central, peripheral, sopite related ($p<0.001$) and between group difference were found for G($p=0.02$), C($p<0.001$), P($p=0.01$), S($p=0.02$) suggesting vestibular adaptation exercises showed more significant improvement than controlled breathing exercises.
Conclusion: The study concluded that vestibular adaptation exercises are more effective than controlled breathing exercises in motion sickness.

Keywords: motion sickness, vestibular adaptation exercises, controlled breathing, motion sickness assessment questionnaire

Introduction

Motion sickness otherwise called travel sickness, is a condition in which a disagreement exists between visually perceived movement and vestibular system's sense of movement [1] It is a specific disorder which is evoked in susceptible persons and animals when they are expose to movements which have definite expressions [2].

About 33% of people are vulnerable to motion sickness even in mild conditions such as being on a boat in calm water, although nearly 66% of people vulnerable in more circumstances [8]. People with migraine (26.31%), gastrointestinal disorders (26.82%), spatial disorientation (33.05%), and those who are sensitive to unpleasant odors (26.64%), Females (27.3%) are vulnerable to motion sickness than males (16.8%) [1] It is induced by variety of motion of environments (e.g cars, boat, planes, tilting trains, funfair rides, space, virtual reality) [4].

The brain responds to unacquainted motion stimuli which are transmitted to vestibular nuclei whenever there is unintentional movement of the body. This unfamilier motion stimulus acknowledged by vestibular labyrinth. The eyes and proprioceptors are carried to vestibular nuclei. Then by cerebellum to vomiting centre which is located in parvicellular formation of medulla oblangata. Motion sickness is caused by disagreement among brain and three pathways [3, 10].

Currently the 'neural mismatch theory' affirms that motion sickness can arise from within a single sensory system (e.g.canal-otolith interaction), or between two or more sensory systems(e.g visual vestibular interaction) [11]. Repetitive vestibular stimulation can therefore bring changes in vestibulo-ocular reflex(VOR)and at same time reduces sensitivity to motion sickness.(3) Disruption of fluid balance is more in sudden jerky movements as they tend to be worse for provocating motion sickness than slower smooth ones [1].

Nausea and vomiting are primary signs and symptoms of motion sickness [5].

Unlike ordinary sickness, vomiting in motion sickness tends not to alleviate the nausea [1].

Stomach awareness, sweating, facial pallor, sometimes increased salivation, sensation of bodily warmth, dizzness, drowsiness, headache and loss of apetite and increased sensitivity to odors comprise relative symptoms [5].

Motion sickness is a familier health problem for a large percentage of population. Most of the drugs have negative side effects. The use of diaphragmatic breathing, a non-pharmacological method, is a positive alternative. The effects of breathing strategy have explored by many of experts. Paul Lehrer a leading researcher in area of relaxation training revealed that breathing technique can be successful in decreasing physiologic activation of sympathetic nervous system [19] In every situation the autonomic nervous system does not function similarly, motion sickness is usually going along with an increase sympathetic activity and reduction in parasympathetic activity. So, slow diaphragmatic breathing may be particularly helpful as it increases an individual's capacity to self -manage the symptoms of motion sickness by decreasing sympathetic tone [20].

Vestibular rehabilitation therapy

Vestibular rehabilitation or visual rehabilitation therapy is a form of physical therapy that uses specialised exercises that results in gaze and gait stabilization [1]. It is an exercise based routine programme primarily designed to decrease vertigo, dizziness, gaze instability and or imbalance or falls [6]. Nearly all VRT exercises require head movements and are crucial in stimulating and retraining the vestibular system [1]. To enhance gaze stability, to enhance postural stability, to improve vertigo, to improve ADL's are the goals of VRT [7]. Use of existing neural mechanism in the human brain for adaptation plasticity and compensation is the basis for success of VRT. The level of vestibular adaptation and compensation is closely associated with the direction, duration, frequency, magnitude, and nature of retraining stimulus. Vestibular adaptation exercises makes an effort to train our body to compensate and recover our sense of balance [1].

Vestibular System

The vestibular system is system of balance. It functions for maintaining visual fixation during head movements and in maintaining posture and lower muscular control [13]. It is a complex sensory organization which involves the communication between the peripheral vestibular apparatus, the ocular system, postural muscles, the brainstem, cerebellum and the cortex. Small structures in the inner ear forms the vestibular apparatus and detect head movement and gravitational forces on the body [14]. Signals constitute angular and translational motion of the head as well as the tilt of head relative to gravity are translated by peripheral vestibular organs in the inner ear. This sensory information is used in order to control reflexes which are used for maintaining the stability of the images on retina during head movements [15]. Earlier studies have been shown that vestibular adaptation exercises and controlled breathing exercises are effective treatment for motion sickness and also an alternative for drug therapy. There is no evidence of comparison between these two techniques. Thus, aim of this study is to compare the effectiveness of vestibular adaptation versus controlled breathing exercises for motion sickness.

Objectives

1. To find out effect of vestibular adaptation exercises for motion sickness.
2. To find out effect of controlled breathing exercises for motion sickness.
3. To find out effect of vestibular adaptation versus controlled breathing exercises on motion sickness assessment questionnaire.
4. To compare the effect of vestibular adaptation versus controlled breathing for motion sickness.

Materials and Methods

An ethical approval was taken by the ethical committee of the institution before undertaking the study and a written consent was taken from the subjects explaining the entire procedure of the study before recruiting them in the study.

Study design

Pretest-Posttest Experimental Design

Sample size

A total of 30 participants were recruited in the study, with 15 participants in each group.

Inclusion criteria

- Those who are willing to participate
- Age 18-30yrs
- Presence of signs and symptoms of motion sickness since 1 to 3months
- Visual acuity 6/6 on snellen's chart.
- Road travelers who are travelling from bus and car
- Long distance (about 3to4 hours) or short distance travelling (about ½ or 1 hour)
- Straight highways as well as winding roads.

Exclusion criteria

- Postural instability
- Migraine
- Neurological deficit
- Cognitive, perceptual problems
- Pregnant females

Randomisation

Setting and location of the study: Tertiary care hospitals, Miraj.

Allocation: Subjects were allocated in the Group A (Controlled breathing exercise) and Group B (Vestibular adaptation exercise) by using the chit method.

Implementation: The method of randomisation and allocation of the samples in the study was done by the researchers themselves.

Procedure

Pre-test was done using Motion sickness assessment questionnaire as the outcome measure, proceeding with the Exercise protocol

Group A-Controlled Breathing (15mins)

Rest in comfortable position and start breathing with your stomach

Eyes are closed mouth is relaxed, lips apart

Shoulders are sloped and eve, elbows bent, hands curled, knees apart, feet apart

Place your right hand just below your rib cage on top of your stomach. Just exhale first to release air from your body.

Take breath air in, let the stomach gently rise as if you are pushing your stomach up with column of air coming in. then release your muscles and let the air go just as you did at first.

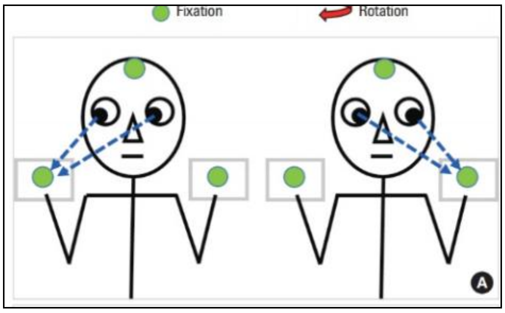
Rest for 10 sec before you take air in again to start another breath cycle

Fig 1

Group B-Vestibular Adaptation Exercises (15mins)

Moving head while focused

Focus your gaze on card paper about 5 feet away. Keep your eyes focused on this object while you turn your head from side to side, slowly at first, then more rapidly.

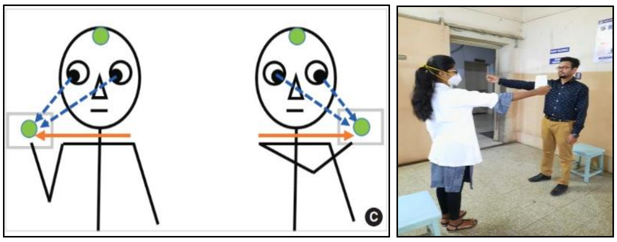


Intensity -5rep (30sec)
Total -15rep (1min break after 5rep)
Duration-5min

Fig 2

Focus on moving target

Follow the movement with your eyes while remaining still. The direction of the targets movement will vary, from side to side to up and down and diagonal.

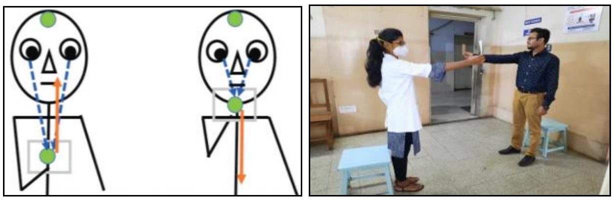


Intensity-5rep (30sec)
Total - 15rep (1minbreak after 5 rep)
Duration-5rep

Fig 3

Move with moving target

While focused on target the patient is asked to move his or her head in the opposite direction of the target, while keeping your eyes locked to the target. The patient may also be asked to move in the same direction as the target.



Intensity-5rep (30sec)
Total -15rep (1 min break after 5 rep)
Duration-5min

Fig 4

Statistical analysis

The statistical analysis was done by using SPSS version 20. Pre and Post treatment outcomes of motion sickness assessment questionnaire (MSAQ) was done using paired t test and between the group analysis was done using an unpaired t test.

Results

Table 1: Gender wise distribution of motion sickness

Gender	Frequency	Percent
Females	15	50
Males	15	50
Total	30	100

Table 1 shows gender wise distribution of frequency and percentage of motion sickness

Table 2: Mode of travel wise distribution of motion sickness

Travelled by bus/car	Frequency	Percent
Bus	26	86.7
Car	4	13.3
Total	30	100

Table 2 shows mode of travel wise distribution of frequency and percentage of motion sickness

Table 3: Gender wise comparison in both groups

Gender	Group		Total	Chi square statistic	p value
	A	B			
Females	7	8	15	0.13	0.72
Males	8	7	15		
Total	15	15	30		

Chi square test of independence was done to compare gender wise in both the groups.

No significant difference was found gender wise in both the groups (p>0.05).

Table 4: Mode of travel wise comparison in both groups

Travelled by bus/car	Group		Total	Chi square statistic	p value
	A	B			
Bus	13	13	26	0.00	1.00
Car	2	2	4		
Total	15	15	30		

Chi square test of independence was done to compare travelling by bus/car in both the groups.

No significant difference was found travelling by bus/car in both the groups (p>0.05).

Table 5: Components of motion sickness of MSAQ at baseline and after 2 weeks

	Mean		Std. Dev.		Paired t statistic	p value
	Baseline	week 2	Baseline	week 2		
	Gastrointestinal					
Group A	67.04	62.03	13.81	13.72	16.47	<0.001
Group B	71.28	52.21	9.50	6.09	2.74	0.01
	Central					
Group A	27.7	24.73	4.15	4.43	10.37	<0.001
Group B	23.54	18.97	4.75	3.93	8.27	<0.001
	Peripheral					
Group A	60.48	54.83	9.46	9.27	11.75	<0.001
Group B	64.65	45.69	8.24	9.56	28.09	<0.001
	Sopite related					
Group A	59.07	55.18	10.06	10.5	10.81	<0.001
Group B	61.65	46.3	11.07	9.37	15.97	<0.001

Paired t test was done to compare between baseline and after week 2 in both the groups Group A- controlled breathing and Group B-vestibular adaptation exercises.

There was significant difference between baseline and week 2 readings for both the groups A and B at each of the MSAQ components gastrointestinal, central, peripheral, spite related (p<0.001).

Group A- controlled breathing

- Mean gastrointestinal score at week 2 (62.03) was significantly smaller than mean gastrointestinal score at baseline (67.04) (p<0.001).
- Mean central score at week 2 (24.73) was significantly smaller than mean central score at baseline (27.7) (p=0.01).
- Mean peripheral score at week 2 (54.83) was significantly smaller than mean peripheral score at baseline (60.48) (p<0.001).
- Mean sopite related score at week 2 (55.18) was significantly smaller than mean spite related score at baseline (59.07) (p<0.001).

Group B-vestibular adaptation exercises

- Mean gastrointestinal score at week 2 (52.21) was significantly smaller than mean gastrointestinal score at baseline (71.28) (p=0.01).
- Mean central score at week 2 (18.97) was significantly smaller than mean central score at baseline (23.54) (p<0.001).
- Mean peripheral score at week 2 (45.69) was significantly smaller than mean peripheral score at baseline (64.65) (p<0.001).
- Mean sopite related score at week 2 (46.3) was significantly smaller than mean spite related score at baseline (61.65) (p<0.001).

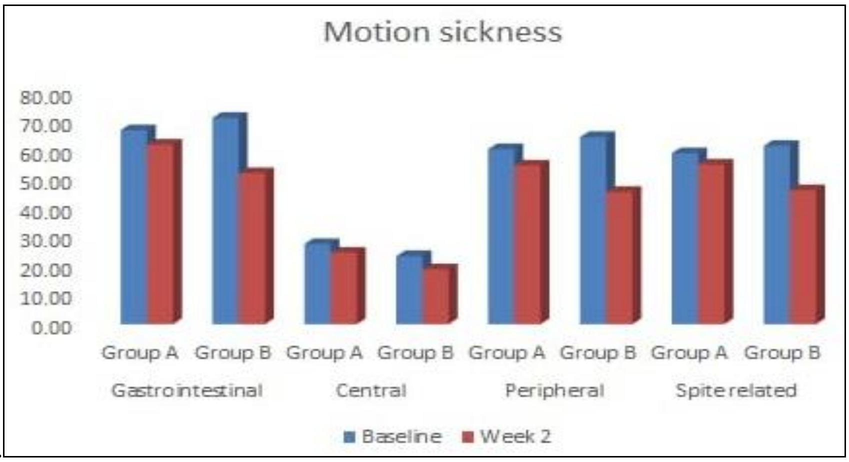


Fig 5: Comparison between Effect on Components of Motion Sickness at Baseline and After 2 Weeks.

Table 6: Comparison between the effect of two groups after two weeks

Parameters	Group	N	Mean	Std. Deviation	Unpaired t statistic	p value
Age	A	15	21.47	2.03	0.88	0.39
	B	15	22.33	3.24		
Days travelled per week	A	15	5.73	0.59	0.00	1.00
	B	15	5.73	0.59		
Motion sickness since months	A	15	1.97	0.58	0.60	0.55
	B	15	2.10	0.63		
Gastrointestinal baseline	A	15	67.04	13.81	0.98	0.34
	B	15	71.28	9.50		
Gastrointestinal week 2	A	15	62.03	13.72	2.53	0.02
	B	15	52.21	6.09		
Central baseline	A	15	27.70	4.18	2.55	0.02
	B	15	23.54	4.75		
Central week 2	A	15	24.73	4.43	3.77	<0.001
	B	15	18.97	3.93		
Peripheral baseline	A	15	60.48	9.46	1.29	0.21
	B	15	64.65	8.24		
Peripheral week 2	A	15	54.83	9.27	2.66	0.01
	B	15	45.69	9.56		

Sopite related baseline	A	15	59.07	10.06	0.67	0.51
	B	15	61.65	11.07		
Sopite related week 2	A	15	55.18	10.50	2.44	0.02
	B	15	46.30	9.37		

Unpaired t test was done to compare between the two groups after two weeks and there was significant difference in all the parameters of Group B patients.

At week 2

- Mean gastrointestinal score at week 2, for group B (52.21) was significantly smaller than mean gastrointestinal score for group A (62.03) (p=0.02).
- Mean central score at week 2, for group B (18.97) was significantly smaller than mean central score for group A (24.73) (p<0.001).
- Mean peripheral score at week 2, for group B (45.69) was significantly smaller than mean peripheral score for group A (54.83) (p=0.01).
- Mean sopite related score at week 2, for group B (46.30) was significantly smaller than mean sopite related score for group A (55.18) (p=0.02).

The results were found to be statistically significant within Group A and B by using Paired t test suggesting both the techniques are reliable, however between group, results were analysed using Unpaired t test suggesting vestibular adaptation exercises showed more improvement than controlled breathing exercises on motion sickness.
Hence the study accepts alternative hypothesis and rejects null hypothesis

Discussion

Mainly motion sickness is not acknowledged until nausea and vomiting are elicited, decrease in performance may not be acknowledged as being suggestive of motion sickness. [18] Peter J Gianaros, Eric R. Muth suggested that Motion sickness may be more appropriately considered as amultidimensional construct. This multidimensional syndrome comprises of various symptoms which affect the travelers which further have an effect on their journey. They are -The nausea syndrome comprised of at least three dimensions: Gastrointestinal distress (sick, queasy, ill, stomach awareness/discomfort, vomiting),
Somatic symptoms (lightheaded, shaky, tired/fatigued, sweaty, weak, warmth) and Emotional distress (upset, worried, hopeless, panicked, nervous, scared/afraid), Sopite related symptoms (drowsiness, yawning, and disengagement from the environment).

Earlier studies have been shown that vestibular adaptation and controlled breathing exercises are effective in improving motion sickness and best method for preventing motion sickness without use of medications that has undesired side effects. Present study was designed to compare the effect of vestibular adaptation and controlled breathing exercises for motion sickness. Total 30 subjects were screened according to selection criteria. The 30 participants were willing to participate in intervention programme and continued full treatment. 30 participants with age group of 18-30 years were given the intervention.

In this study outcome measure was assessed by using motion sickness assessment questionnaire. Data was analysed using mean, standard deviation, chi sqaure test of independence which showed no significant difference in gender wise and mode of travel wise distribution in both the groups. Paired t test showed that there was significant difference within Group A and Group B at baseline and after 2 weeks and unpaired t test showed that there was significant difference between Group A and Group B which suggests that vestibular adaptation exercises showed more significant improvement than controlled breathing exercises. The result of MSAQ depict that motion sickness improved significantly in Group B participants as indicated by decrease in mean values.

Some studies reveal that by giving vestibular adaptation exercises there is reduction in signs and symptoms of motion sickness. An article by Rose Mary Rine, Michael Schubert and Thomas J Balkany reports that physical therapy for motion sickness in a 34 year old woman. Describing the evaluation and treatment of patient with motion sickness was the motive of this study. The patient at first had moderate to severe visually induced motion sickness, which had an effect on her functional abilities. Following 10 weeks of a primary home- based program of vestibular rehabilitation and balance training, her symptoms were decreased and she could start again all work related activities. [16] The sensory conflict hypothesis by Reason and Brand et al implies that, 'how' of motion sickness is based on some form of sensory conflict or sensory mismatch. The sensory conflict or sensory mismatch comprise intra-vestibular disagreement between rational accelerations recognized by the semi-circular canals and linear -translational accelerations (including gravitational) recognized by otolith.[11]

Furthermore this study suggests that because of continues exercises the progress was constant. This proves that with consistent exercises there is considerable improvement. Study has been done by Martarelli *et al*, Diaphragmatic breathing reduces exercise-induced oxidative stress caused by prolonged, intense exercise. Result indicated that diaphragmatic breathing significantly reduced exercise induced oxidative stress and increased the activity of the antioxidant defense system. [17]

The result of this study revealed that symptoms of motion sickness of Group B patients were reduced at the end of 2nd week than Group A. The MSAQ total score from baseline and by the 2nd week was found to be decreased in Group B patients as indicated by decrease in mean values. The study concluded that vestibular adaptation exercises are more effective than controlled breathing exercises for motion sickness.

Conclusion

This study supported alternate hypothesis i.e., we found a significant difference between effects of vestibular adaptation exercises and controlled breathing exercises on motion sickness. This study concluded that, Vestibular adaptation exercises are more effective than controlled breathing exercises for motion sickness.

Limitations and Suggestions

Limitations

1. Small sample size

2. Short duration

Suggestions

1. The study is done for longer duration.
2. The study can be done in the other age group.
3. The study can be done with the different group of gender.
4. Sample size can be improved.
5. Duration of vestibular adaptation exercises can be improved.

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