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Effectiveness of visual vestibular habituation and controlled breathing for motion sickness

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Abstract
Traditional pharmacological treatment for Motion sickness offers limited improvement and side effects for many travelers. Habituation therapy and breathing exercises are non-pharmacological method and an alternative to drug therapies for motion sickness. 30 young participants of Pravara Rural Hospital, Loni susceptible to motion sickness were evaluated. Visual Vestibular Habituation Exercises and Controlled Breathing techniques were given to the participants for 5 days per week for 2 weeks for 45 minutes. Effects of the intervention were evaluated using Diagnostic Severity criteria for Motion Sickness and Motion Sickness Assessment Questionnaire (MSAQ). Paired t test analysis was computed. Result showed statistically significant improvement from baseline and at the end of 2nd week of intervention. Study concluded that combined effectiveness of both techniques caused habituation for motion sickness which improved symptoms and decreased sensitivity for motion sickness as quickly as 2 week of intervention and was effective as long as till 8th week.

Keywords: hospitals, rural, exercise therapy, motion sickness, vestibule, labyrinth

1. Introduction

Innovation of transport and industry have led to provocative motion environments, to cars, trains, funfair rides, aircraft, and simulators [1]. Thus Motion sickness is a common problem in people travelling by train, airplane, boat and especially cars. Also, people experience motion sickness from virtual reality, displays and also smart phones [2]. Predisposition to motion sickness is higher in people with migraine (26.31%), gastrointestinal disorders (26.82%), spatial disorientation (35.05%) and those who are sensitive to unpleasant odors (24.64%). Females (27.3%) are more susceptible to motion sickness than males (16.8%) [3]. Initial symptoms is discomfort in stomach, followed by nausea. With rapid worsening of symptoms there can be salivation changes, dizziness, retching and sopite related symptoms [4, 5].

The primary functions of the vestibular system are spatial orientation, maintenance of balance, and stabilizing of vision through vestibular–ocular reflexes [6]. Motion is documented by the brain through three different pathways that send signals coming from inner ear (sensing motion, acceleration, gravity), the eyes (vision), and the deeper tissues of body surface (proprioceptors). When there is an unintentional movement of the body, the brain responds to unfamiliar motion stimuli which are transmitted to vestibular nuclei. This unacquainted motion stimuli is recognized by vestibular labyrinth, the eyes and proprioceptors and travel to vestibular nuclei, then through cerebellum to vomiting Centre located in the parvicellular formation of medulla oblongata, this conflict among the brain and the three pathways lead to motion sickness [7]. Currently the "neural mismatch theory" states that motion sickness can originate from within a single sensory system (e.g., canal-otolith interaction), or between two or more sensory systems (e.g. visual-vestibular interaction) [8, 9].

As the vestibular system plays a vital role in stimulation of motion sickness, vestibular habituation exercises will help reduced motion sickness. Repetitive vestibular stimulation can therefore cause changes in Vestibulo-Ocular Reflex (VOR) and at the same time a decrease in sensitivity to motion sickness [10]. Habituation exercises are based on the mechanism that repeated exposure to a provocative stimulus (e.g. head movements) will lead to a reduction of the motion-provoked symptoms [11]. These exercises cause a habituation effect characterized by decreased sensitivity and duration of symptoms can occur in as quickly as 2 weeks but can take as long as 6 months [12]. Effects of breathing strategy have explored by number of experts. Paul Lehrer a leading researcher in area of relaxation training showed that breathing technique can be quite successful in reducing physiologic activation of the sympathetic nervous systems [13].

A commonly used Diagnostic Criteria for Identifying the Severity of acute motion sickness and the Diagnostic Scale, referred to as Motion Sickness Assessment Questionnaire which is a reliable method for scoring overall motion sickness with the use of four subscales is used in this study for rating these symptoms of motion and to differentiate motion sickness symptoms along four dimensions: gastrointestinal, central, peripheral, and sopite-related [14].

Motion sickness affects most of the people who travel by air,

land or sea, little credentials exists regarding prevention and management. Repeated recurrence of sickness is not desirable or practical to daily living. Limited evidence is available for Controlled breathing and visual-vestibular habituation training for motion sickness that won't aggravate the undesirable symptoms and can last for a year. Thus, aim of this study was to help determine the effectiveness of visual vestibular habituation and controlled breathing for motion sickness.

2. Materials and methods

2.1 Design

The design was experimental study conducted in the Department of Neurosciences Physiotherapy, Dr. A.P.J. Abdul Kalam college of Physiotherapy, PIMS, Loni. The study duration was for 2 months (10 Sep2017- 27 Nov2017), with intervention of 5 days per week for 2 weeks. The outcome measures, Motion Sickness Assessment Questionnaire (MSAQ) and Diagnostic criteria for identifying the severity of acute motion sickness was assessed at Baseline and at the end 2nd week of intervention also a follow up was taken at the end of 8th week. The study was approved (Ref. No. PIMS/CPT/IEC/2017/511) from the Institutional Ethical Committee of Dr. A.P.J. Abdul Kalam College of Physiotherapy, Pravara Rural Hospital. Written informed consent was obtained for experimentation with human subjects.

2.2 Participants

Study was done using convenient sampling, 30 participants were selected for the study. Young adults of Pravara Rural Hospital, Loni susceptible to motion sickness were eligible to participate in study if they had visual acuity 6/6 on Snellen chart and those diagnosed with motion sickness according to criteria for identifying the severity of acute motion sickness. Participants between age group 18-30 years and road travelers were included. Participants diagnosed with postural instability, vestibular disorders, migraine with neurological deficit and orthopedic condition, cognitive and perceptual deficit. Also, Participants with any respiratory problems and pregnant females were excluded from the study.

3. Intervention

Total 46 subjects were screened out of which 5 did not fit in inclusion criteria. Then written informed consent was obtained from the participants**.** Pre-training baseline scores were obtained for Motion Sickness Assessment Questionnaire (MSAQ) and Criteria for identifying the severity of acute motion sickness. Instructions were given to fill the questionnaire on the basis of road travelling experience. Before starting with the training session, few trials were given to the participants for the visual vestibular habituation exercises and controlled breathing technique. Out of the remaining 41 participants 4 were not willing to participate in the intervention programme and 7 discontinued the treatment on 3rd day of 1st week of intervention.

The participants performed the exercises in a well-ventilated, spacious exercise therapy unit of the physiotherapy department of Pravara Rural Hospital. Instructions given to the subjects were to turn off their mobile phones or keep them on silent mode, to maintain silence, to concentrate on the breathing pattern, and to concentrate on visual vestibular exercises throughout the session. Participants were told that while doing the exercises they might experience symptoms of motion sickness and were also reminded that they could discontinue the exercise at any time, for any reason (see Table 5 and 6 for Visual vestibular habituation and Controlled breathing Protocol).

The total interventional protocol was conducted for 45 min, i.e. 30 min of Visual vestibular habituation exercises and 15 min for controlled breathing techniques. Intervention was given for 5 days per week for 2 weeks under supervision of researcher. Also, Home exercise program was taught which will be twice per week for remaining 8 weeks. To rule out the bias participants were requested to avoid travel during 2 weeks of intervention.

The participants demonstrated an ability to safely complete stage 1 visual vestibular exercises, step 1 through 5 for 10 sec for first two days of intervention without any increase in symptoms along with diaphragmatic breathing. Then they were asked to continue the same exercises for 30 sec for the remaining 3 days if they experience no increase in symptoms. Those who could not continue the exercises for 30 sec or if they felt increase in symptoms were asked to do the exercises for 10 sec until they felt decrease in symptoms or were instructed to stop if the symptoms were alleviated. They were instructed to monitor their reactions to exercises (e.g. An increase or decrease in symptoms) and to note them in a daily log book. Participants who could complete all stage 1 exercises without symptoms were instructed to proceed to stage 2 activities for the 2 weeks of intervention. They were asked to perform the exercises for 30 sec, if they experience any severe reactions they were told to stop the exercises and contact the therapist. Exercises were to be performed daily. After the end of 2-week re-assessment using, the MSAQ questionnaire and severity of acute motion sickness criteria was done.

4. Outcome Measures

- Diagnostic Criteria for identifying the severity of acute motion sickness [15].
- Motion Sickness Assessment Questionnaire (MSAQ).[14]

5. Data analysis

Mean Standard deviation and Student paired t test was applied for comparison of differences in the pre-intervention and post intervention scores of MSAQ and for the Level of severity of Acute Motion Sickness. To find out the difference from the Baseline and at the end of 2nd week, comparison was done between the scores obtained within the same group. The results were concluded to be statistically significant with p value <0.0001.

Table 1: Difference of Level of severity of Acute Motion Sickness at Baseline and week 2

Mean + SD	't' value	'p' value
8.2 + 4.93	5.152	<0.0001
3.83 + 3.71		<0.001

Result: Significance with p value <o.ooo1 with 95% confidence interval

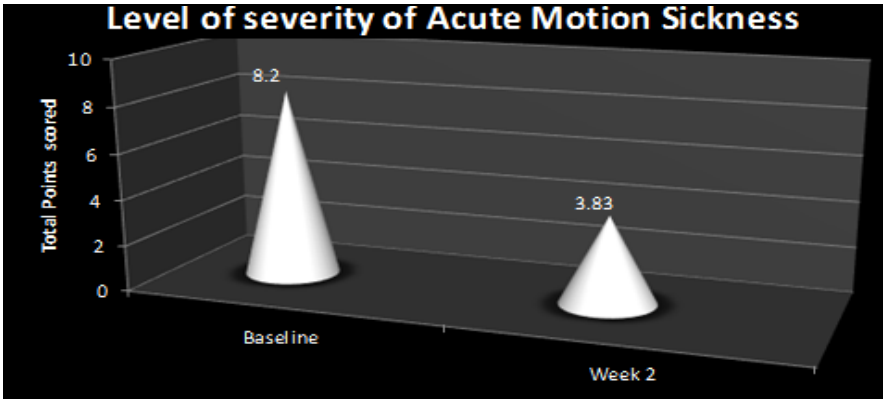

Fig 1

Table 2: Components of Motion Sickness of MSAQ at Baseline and week 2

Components of Motion Sickness	Baseline Mean ± SD n= 30	Week 2 Mean ± SD n = 30	't' value	'p' value
Gastrointestinal	47.21 ± 17.21	23.11 ± 14.28	8.319	p <0.0001
Central	26.72 ± 16.49	13.58 ± 6.62	4.65	p <0.0001
Peripheral	22.10 ± 15.63	14.29 ± 8.85	4.178	p< 0.0002
Sopite Related	41.35 ± 20.84	21.95 ± 12.47	5.541	p <0.0001

Result: Significance with p value <o. ooo1 with 95% confidence interval.

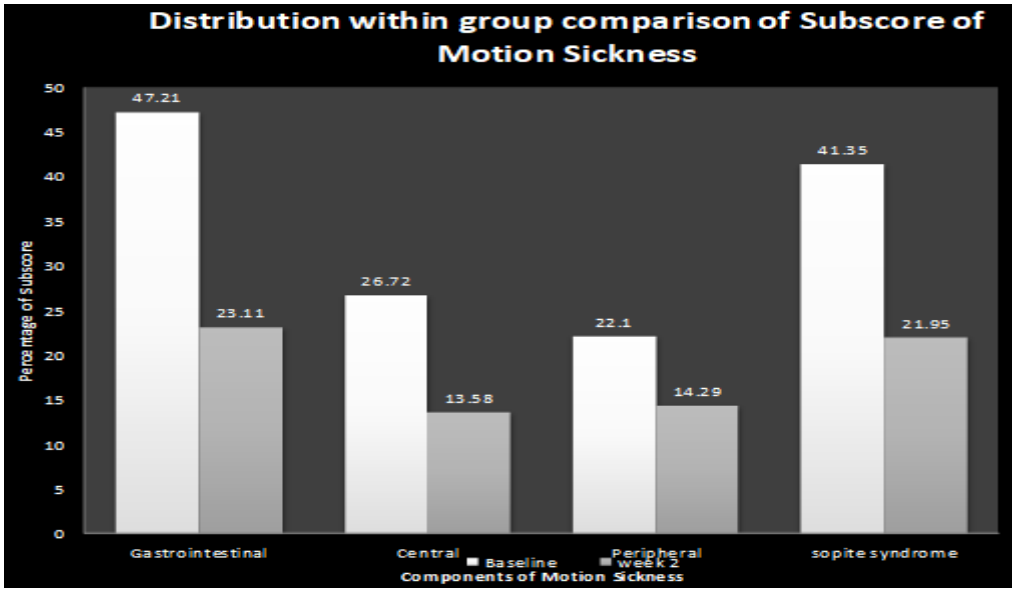

Fig 2

Table 3: Difference of Total score of MSAQ at Baseline and week 2

	Mean + Standard Deviation	't' value	'p' value
Baseline	37.43 ± 13.52	7.149	<0.0001
Week 2	20.28 ± 8.75		

Result: Significance with p value <o.ooo1 with 95% confidence interval

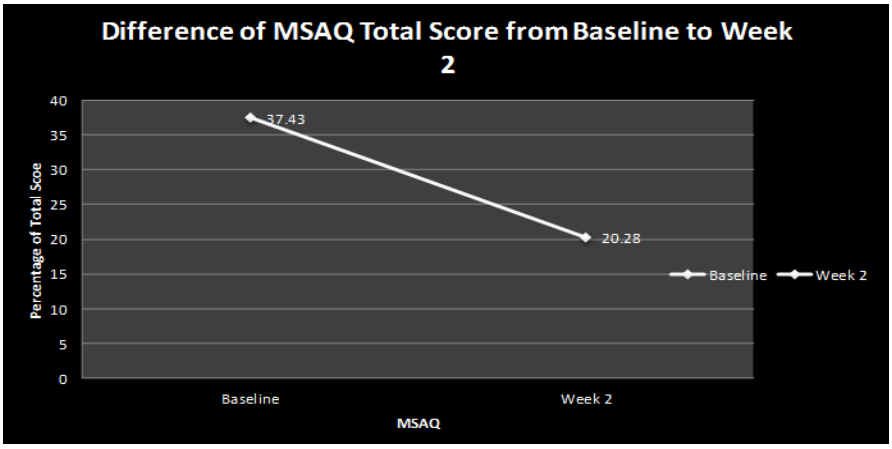

Fig 3

Table 4: Difference of MSAQ Total score & Level of severity of acute motion sickness of 10 participants at the end of 8th week of intervention**.**

Result of MSAQ Total score				Result of severity criteria		
SR no	**Week 1**	**Week 2**	**Week 8**	**Week 1**	**Week 2**	**Week 8**
1	19%	16%	16%	7MIIA	4MIIB	6MIIA
2	50%	32%	12%	11MIII	4MIIB	NONE
3	30%	24.30%	12%	5MIIA	4MIIB	4MIIB
4	62%	38%	31.25%	12MIII	8MIII	7MIIA
5	25%	16%	12%	6MIIA	2MI	NONE
6	22%	15%	14%	5MIIA	4MIIB	NONE
7	43%	21.16%	13.19%	18Frank	3MIIB	NONE
8	29.16%	21.77%	11.11%	4MIIB	NONE	NONE
9	66%	14%	15.00%	19Frank	2MI	4MIIB
10	53.47%	18.05%	38.19%	12MIII	16Frank	16Frank

6. Results

To find out the Effectiveness of visual vestibular habituation and controlled breathing for motion sickness 30 participants were included in this study. The intervention was given for 2 weeks and the exercises were performed 5 days per week. Participants were treated with visual-vestibular habituation and controlled breathing. At the start of 1st week and at end of 2nd week of intervention participants were reassessed using the Severity criteria for acute motion sickness and MSAQ scale. The following are the results of the study:

- **Table 1:** Shows
  - Comparison of total score in level of severity of acute motion sickness between Baseline and at the end of 2nd Week.
  - Comparison of total score in level of severity criteria for acute motion sickness between the Baseline and at the end of 2nd Week was found to be statistically extremely significant using the paired t test in which p value is ($p<0.001$, 95% CI) and t value is ($t= 5.152$) respectively with 29 degrees of freedom.
  - That at the baseline of the intervention out of 30 subjects 3 had Frank sickness, 7 had severe malaise (MIII), 13 had Moderate malaise (MIIA), and 6 had Moderate malaise (MIIB) and 1 with slight malaise (MI).
  - That at the end of 2nd week of intervention subjects having Frank sickness at baseline their level of severity for motion sickness was decreased to MIII, MIIA & MIIB & MI.
  - That at the end of 2nd week of intervention subjects having severe malaise at baseline their level of severity for motion sickness was decreased to MIIA, MIIB & MI.
  - That at the end of 2nd week of intervention subjects having Moderate malaise (MIIA &MIIB) at baseline their level of severity for motion sickness was decreased to MI or zero (having no motion sickness) or remained the same(moderate).
  - That at the end of 2nd week of intervention subjects having slight malaise (MI) at baseline their level of severity for motion sickness was decreased to zero (having no motion sickness at all).

- **Fig 1:** Shows decrease in Mean value of level of severity for acute motion sickness from the Baseline and at the end of 2nd week of intervention was 8.2(SD 4.93) and 3.83(SD 3.71) respectively.

- **Table 2:** shows
  - The comparison of Components of motion sickness at baseline & at the end of 2 week of intervention.
  - The most common symptom of motion sickness among the 30 subjects at baseline was the Gastrointestinal (sick, queasy, ill, stomach awareness/discomfort, vomiting). Followed by Sopite related (irritated, drowsy, fatigue, uneasy) then central (faint-like, lightheaded, dizzy, spinning) and

Peripheral (sweaty, clammy, hot/warm,).

- Comparison of MSAQ Sub score of the Baseline and at the end of 2 Week was found to be statistically extremely significant using the students paired t test in which p' value and t' value for gastrointestinal was ($p<0.0001$, 95% CI) and ($t= 8.319$), for central was ($p<0.0001$,95% CI) and ($t=4.65$), for peripheral was ($p<0.0002$, 95% CI) and ($t=4.178$), for sopite related is ($p<0.0001$, 95% CI) and ($t=5.541$), respectively with 29 degrees of freedom.

- **Fig 2:** shows
  - MSAQ sub scores have decreased at the end of 2nd week as compared to baseline scores.
  - The most common symptoms were the gastrointestinal followed by sopite related then central and peripheral from baseline and at the end of 2nd week was improved.
  - The score for Gastrointestinal was at baseline 47.21(SD 17.21) and at end of 2nd week were 23.11(SD 14.28).
  - The score for central was at baseline 26.72(SD 16.49) and at end of 2nd week were 13.58(SD 6.62).
  - The score for peripheral was at baseline 22.1(SD 15.63) and at end of 2nd week were 14.29(SD 8.85).
  - The score for sopite related was at baseline 41.35(SD 20.84) and at end of 2nd week were 21.95(SD 12.47).

- **Table 3:** Shows the difference of MSAQ total score from Baseline and at 2 weeks was found to be statistically extremely significant using the paired t test in which p value is ($P<0.0001$, 95% CI) and t value is ($t=7.149$) respectively with 29 degrees of freedom.

- **Fig 3:** Shows the decrease in Mean value of MSAQ total score from the Baseline and at end of 2nd Week of intervention was 37.43(SD 13.52) and 20.28(SD 8.75) respectively.
  Also, the average age is 20.3

- **Table 4: Shows**
  - Results MSAQ Total score & Result of severity criteria at the end of 8th week
  - Out of 30 participants only 10 subjects travelled and were reassessed after 8th week of intervention.
  - That for MSAQ total score & severity criteria at the end of 8th week, out of 10 subjects there was increase in score for 2 subjects at the end of 8th week & for 1 participant the score remained the same as per 2nd week, for the remaining 7 participants score of MSAQ decreased.
  - That on comparison from baseline and at the end of 2nd week & 8th week showed that the visual-vestibular habituation exercises and controlled breathing with home exercise programme was effective and helped subjects to decrease their motion sickness.
  - That these exercises caused a habituation effect and decreased their motion sensitivity in quickly as 2 week and was effective as long as till 8 weeks

7. Discussion

Mostly motion sickness is not recognized untill nausea and vomiting are elicited, decrements in performance may not even be recognized as being indicative of motion sickness [16]. Peter J. Gianaros, Eric R. Muth suggested that motion sickness may be more appropriately viewed as a multidimensional construct. This multidimensional syndrome consists of various symptoms which affect the travellers which further affects 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)

The present study was designed to investigate whether the visual vestibular habituation exercises and controlled breathing can improve motion sickness as the best methods for preventing motion sickness without the use of medication that has undesired side effects. Total 46 subjects were screened out of which 5 did not fit in inclusion criteria. Out of the remaining 41 participants 4 were not willing to participate in the intervention programme and 7 discontinued the treatment on 3rd day of 1st week of intervention. 30 participants of 18-30 years of age were given the intervention.

In this study outcome measure was assessed by using the severity criteria of acute motion sickness and Motion Sickness Assessment Questionnaire (MSAQ). Data was analysed using mean, standard deviation and student paired t test which showed positive effect of habituation exercises and controlled breathing on decreasing the symptoms and their motion sickness. The results of Motion Sickness Assessment Questionnaire & the severity criteria of acute motion sickness depict that the motion sickness improved significantly after 2 weeks of intervention as indicated by decrease in mean values. Also, a home exercise programme was given for 8th weeks, results at the end of 8th week showed that those who followed the home exercise programme, the visual vestibular habituation exercises caused habituation effect in them and had decreased their motion sensitivity. Although subjects were not completely free of symptoms, but their ability to function while travelling was no longer limited and their symptoms were mild. Furthermore, the study suggests that during the time the patient reduce the amount of exercise, the progress was minimal. This leads to conclusion that with an increase in amount of exercise and level of difficulty, improvement is increased.

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 includes the intra-vestibular conflicts between rotational accelerations sensed by the semi-circular canals and linear-translational accelerations (including gravitational) sensed by the otolith [17].

Habituation is superior to anti-motion sickness drugs, and it is free of side effects. The most extensive habituation programmes, often denoted "motion sickness desensitisation," are run by the military, where anti-motion sickness medication is contraindicated for pilots because of side-effects including drowsiness and blurred vision. Neural structures such as the amygdala as well as such areas as the nucleus tractus solitarius are thought to be important in processes of induction of and habituation to motion sickness. Habituation programmes have success rates exceeding 85% but can be extremely time consuming, lasting many weeks. Critical features include:

Iron occurs in nature as Magnetite or black iron ore (Fe_3O_4). The mineral is composed of FeO and Fe_2O_3 and is magnetic – a fact that proves useful in locating deposits. It occurs in the ore as a dense, grained lustrous black – blue mass disseminated in siliceous or siliceous – argillaceous gangue. They are difficult to reduce but when oxidized to martite (Fe_2O_3), reduction becomes easy. They contain 50 – 60% Fe. Hematite or red iron ore is an anhydrous iron oxide Fe_2O_3, softer than magnetite. A piece of the ore leaves a red track on porcelain when scratched upon. Hematite is formed as result of weathering the magnetite. Hematite contains 50 – 70%. They are easily reducible to metallic form. Their gangue is siliceous. Limonite (brown ore), Fe_2O_3. $3H_2O$, is formed by weathering and oxidizing other iron ores and contains.

a. The massing of stimuli (exposures at intervals greater than a week almost prevents habituation),
b. Use of graded stimuli to enable faster recoveries and more sessions to be scheduled, which may help avoid the opposite process of sensitization, and
c. Maintenance of a positive psychological attitude to therapy [18].

Miles and Braitman examined activity in cranial nerve VIII and reported that the changes are not due to adaptation at the peripheral level, but rather to habituation that involves central nervous system changes [19].

A fight between visual and vestibular information concerning spatial orientation has been recognized as the primary causal factor for motion sickness, and visual stimuli alone have been shown to induce motion sickness symptoms [20]. The intervention presented in this study was developed based on these reports and implemented for a patient with vision-induced motion sickness.

A similar study was done by Rose Marie Rine et al, 'Visual-Vestibular Habituation and Balance Training for Motion Sickness' a case report which describes physical therapy for motion sickness in a 34-year-old woman. The patient primarily had visually persuaded motion sickness, which affected her functional abilities and prevented her from working. After 10 weeks of home exercise program her symptoms were improved and she could continue all work-related activities. Although this case report cannot explain how improvement was achieved the treatment was based on the sensory conflict theory and that the effectiveness of habituation is stimuli specific [20].

Another study done by Shane M. Meyer et al, 'Visual Vestibular Habituation as an Effective Treatment for Motion Sickness' A pilot study consisting of 29 subjects demonstrated visual-vestibular habituation and reduction of motion sickness symptom scores in prone individuals from 13.0 ±4.4 to 1.5 ± 3.1 eighteen weeks after habituation. A randomized controlled, double blind, trial with 20 subjects demonstrated an overall reduction in the peak velocity and in time constant of 17.2% and 22.7% respectively ($p<0.05$) with vestibular training. A pilot study demonstrated figure skaters, due to their habituation, were less susceptible to motion sickness than were controls (2.8 ± 2.8 vs. 16.2 ± 13.7; <0.01) [10].

Also, a study 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 defence system [21].

The results of this study showed that their symptoms of motion sickness were reduced at the end of 2nd week. After the end of 8th week again data was collected from 10 participants who travelled. The MSAQ total score and sub scores from Baseline and at the end 2nd week & 8th week was found to be decreased as indicated by decrease in mean values. This concluded that subjects having most common symptoms of Gastrointestinal (sick, queasy, ill, stomach awareness/discomfort, vomiting) followed by Sopite related (irritated, drowsy, fatigue, uneasy), central (faint-like, lightheaded, dizzy, spinning) and Peripheral (sweaty, clammy, hot/warm,) were reduced and experienced only slight motion sickness (mild light-headedness, clammy but no nausea, dizziness or sweating) respectively. On comparison of total score in level of severity criteria for acute motion sickness between the Baseline and at the end of 2nd Week & 8th week was found to be improved, as those having Frank, severe or moderate malaise was decreased to moderate to mild. For few the symptoms of motion sickness were completely resolved.

Although time alone may have resulted in reduction of symptoms, this study indicates worsening of the symptoms while travelling which did not stabilize or reduce until the exercise regimen began. Thus, the study can be generalized to all individuals with motion sickness; it describes a non-pharmacological treatment option for this syndrome. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors

8. Footnotes

Ruler, Timer, Couch and Pillows, Sitting stool, Index card paper with 0.5in' letters on it, Snellen chart, MSAQ, Severity Criteria.

9. Conclusion

Results of present study revealed that inclusion of Visual vestibular Habituation exercises and Controlled breathing produced significant effect for motion sickness. However, results showed that on comparison of SD, Mean & student paired t test from baseline and at the end of 2^{nd} & 8^{th} week was found to be statistically extremely significant. Also, there was decrease in scores of MSAQ & Severity criteria from baseline and at the end of 2^{nd}, 8^{th} week which concludes that combined effectiveness of visual vestibular habituation and controlled breathing caused habituation and decrease sensitivity as quickly as 2 week and was effective as long as till 8^{th} week which helped in decreasing their motion sickness.

10. Tables

Table 5: Visual Vestibular Habituation Protocol

▪	Exercises are to be carried out daily.
▪	Items needed: index card with 0.5in (1.3cm) letters
▪	Begin at stage 1. Proceed to stage 2 when all activities can be completed with no or minimal, symptoms.
▪	Repeat twice per day each for 30 sec

Stage 1

	Exercises	Frequency/ day & Duration	Position of subjects	Week	Instructions
1.	Move the card from left to right repeatedly as you maintain fixation on letters (hold the card at arm length).	1 time/day for 10 sec	Seated in chair	1st	If you experience no motion sickness and can maintain clear image of the letters at this speed for 10 sec then continue increasing speed for 30 sec
2.	Move the arm and card in up and down directions.	1time/ day for 10sec	Seated in chair	1st	Card centered in front approximately 8 in up and down from center.
3.	Turn your head from left to right keeping your arm and card steady centered in front of you.	1time/day for 10 sec	Seated in chair	1st	Establish maximum speed, as above, & continue for 30 sec.
4.	Repeat step 3, except move your head in up and down direction.	1time/day for 10 sec	Seated in chair	1st	--
5.	Repeat step 4, except tilt your head from side to side.	1time/day for 10 sec	Seated in chair	1st	Bring right ear towards the right shoulder & and left ear towards the left shoulder as you visually fixate on the letters on card, held centered in front of you.

Stage 2

	Exercises	Frequency/ day & Duration	Position of subject	Week	Instructions
6.	Repeat step1 through step 5	1time/day for 30 sec	Standing	2nd	--
7.	Move both your head and card simultaneously from left to right as you fixate on letters on the card.	1time/day for 30 sec	Seated in chair	2nd	Card should be held straight out in front as above.
8.	Repeat as step7, but move the arm and head in up and down direction.	1time/day for 30 sec	Seated in chair	2nd	--
9.	Repeat as step7, but move the arm and head in opposite directions	1time/day for 30 sec	Seated in chair	2nd	E.g., as the arm and card move to right, your head is turned toward the left & vice versa.
10.	As above, move arm and head in opposite directions, but in up and down directions.	1time/day for 30 sec	Seated in chair	2nd	--

Table 6: Controlled Breathing Protocol: Total 15 min
Please remember the rule: you should do nothing to increase your sense of discomfort while you are practicing the breathing.

•	Rest in a comfortable position and start breathing with your stomach, head centered, supported and in the midline of your body.
•	Your eyes are closed, your mouth is relaxed: with lips apart, teeth apart, and tongue relaxed; there's no throat movement.
•	Your shoulders are sloped and even; elbows bent; your hands will be in a curled, relaxed position, not touching one another.
•	Knees are apart; and feet are pointing away from one another at a 45-90-degree angle.
•	Then, place your right hand just below your rib cage on top of your stomach.
•	Just exhale first to release air from your body—it should be a complete, relaxed release where there is no holding, controlling, or forcing of the release.
•	Take breath of air in; let the stomach gently rise as if you are pushing your stomach up with the column of air coming in.
•	Then release your muscles and let the air go just as you did at first when you started the exercise, there is no controlled, gradual release,
•	Rest for 10 seconds before you take air in again to start another breath cycle.
• •	Breathe naturally and not too deeply, avoid over breathing or hyperventilation. If you were to feel light-headed or dizzy, the chances are you are taking in too much air with each breath, take a little less air in on your next breath and the breaths that follow.

- **Visual-vestibular Habituation trial session given by researcher**

Fig 4

Fig 5

- **Subjects performing visual vestibular habituation exercises**

Fig 6: Stage 1 visual vestibular habituation exercises done in sitting position.

Fig 7: Stage 2 visual vestibular habituation exercises done in standing position.

- **Subjects performing Diaphragmatic Breathing**

Fig 8: Participant resting in semi fowler's position

Fig 9: Participant resting in comfortable position with elbows bent, hands below the rib cage on top of the stomach and pillow under the knees and feet pointing away from one another

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12. References

1. Golding JF. Motion sickness susceptibility. Autonomic Neuroscience. 2006; 129(1):67-76.
2. Lackner JR. Motion sickness: more than nausea and vomiting. Experimental brain research. 2014; 232(8):2493-510.
3. Sharma K. Prevalence and correlates of susceptibility to motion sickness. AMG Acta geneticae medicae et gemellologiae: twin research. 1997; 46(2):105-21.
4. Shupak A, Gordon CR, Carlos R. Motion sickness: advances in pathogenesis, prediction, prevention, and treatment. Aviation, space, and environmental medicine. 2006; 77(12):1213-23.
5. Matsangas P, McCauley ME. Sopite syndrome: A revised definition. Aviation, space, and environmental medicine. 2014; 85(6):672-3.
6. Guedry FE, Rupert AR, Reschke MF. Motion sickness and development of synergy within the spatial orientation system. A hypothetical unifying concept. Brain Res. Bull 47.1998, 475-480.
7. Crampton GH. Neurophysiology of motion sickness. Motion and space sickness. 1990:29-42.
8. Oman CM. Motion sickness: a synthesis and evaluation of the sensory conflict theory. Canadian journal of physiology and pharmacology. 1990; 68(2):294-303.
9. Reason JT. Motion sickness adaptation: a neural mismatch model. Journal of the Royal Society of Medicine. 1978; 71(11):819.
10. 10. Meyer SM. Visual Vestibular Habituation as an Effective Treatment for Motion Sickness.2012.

11. Clendaniel RA. The effects of habituation and gaze-stability exercises in the treatment of unilateral vestibular hypofunction–preliminary results. Journal of neurologic physical therapy: JNPT. 2010; 34(2):111.
12. Telian SA, Michael Smith, Neil T. Shepard. Physical therapy program for vestibular rehabilitation. The American journal of otology. 1991; 12(3).
13. Stromberg S. Oswald Social Sciences Honorable Mention: Diaphragmatic Breathing and its Effectiveness in the Management of Motion Sickness. Kaleidoscope. 2014; 11(1):22.
14. Gianaros PJ, Muth ER, Mordkoff JT, Levine ME, Stern RM. A questionnaire for the assessment of the multiple dimensions of motion sickness. Aviation, space, and environmental medicine. 2001; 72(2):115.
15. Graybiel A, Wood CD, Miller EF, Cramer DB. Diagnostic criteria for grading the severity of acute motion sickness. Naval aerospace medical inst pensacola fla. 1968.
16. Graybiel A, Lackner JR. Treatment of severe motion sickness with antimotion sickness drug injections. Aviation, space, and environmental medicine. 1987; 58(8):773-6.
17. Oman CM. Motion sickness: a synthesis and evaluation of the sensory conflict theory. Canadian journal of physiology and pharmacology. 1990; 68(2):294-303.
18. Benson AJ, Nicholson AN, Rainford DS. Motion Sickness. Aviation Medicine. 1999.
19. Miles FA, Braitman DJ, Dow BM. Long-term adaptive changes in primate vestibuloocular reflex. IV. Electrophysiological observations in flocculus of adapted monkeys. Journal of Neurophysiology. 1980; 43(5):1477-93.
20. Rine RM, Schubert MC, Balkany TJ. Visual-vestibular habituation and balance training for motion sickness. Physical therapy.1999; 79(10):949-57.
21. Martarelli D, Cocchioni M, Scuri S, Pompei P. Diaphragmatic breathing reduces exercise-induced oxidative stress. Evidence-Based Complementary and Alternative Medicine, 2011.