Preliminary Evaluation of an Osteopathic Manipulative Treatment to Prevent Motion Sickness

Virginia A. Thomas; Amanda M. Kelley; Albert Lee; Thomas Fotopoulos; Jason Boggs; John Campbell

INTRODUCTION: Motion sickness affecting military pilots and aircrew can impact flight safety and, if severe, can lead to disqualification from flight status. However, due to the common adverse effects of motion sickness pharmaceuticals (e.g., drowsiness), medication options are severely limited. The purpose of this study was to explore the potential utility of a nonpharmaceutical method for motion sickness prevention, specifically an osteopathic manipulative technique (OMT).

METHODS: A novel OMT protocol for the reduction of motion sickness symptoms and severity was evaluated using a sham-controlled, counterbalanced, between-subjects study design. The independent variable was OMT treatment administered prior to the motion sickness-inducing procedure (rotating chair). The primary dependent measures were total and subscale scores from the Motion Sickness Assessment Questionnaire.

RESULTS: The OMT treatment group experienced significantly fewer gastrointestinal (mean scores postprocedure, treatment M = 20.42, sham M = 41.67) and sopite-related (mean scores postprocedure, treatment M = 12.81, sham M = 20.68) symptoms than the sham group while controlling for motion sickness susceptibility. There were no differences between groups with respect to peripheral and central symptoms.

DISCUSSION: The results suggest that the treatment may prevent gastrointestinal (nausea) and sopite-related symptoms (sleepiness). These preliminary findings support further exploration of OMT for the prevention of motion sickness. A more precise evaluation of the mechanism of action is needed. Additionally, the duration of the effects needs to be investigated to determine the usefulness of this technique in training and operational settings.

KEYWORDS: motion sickness, aviation, U.S. Army, osteopathic manipulative technique.

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Motion sickness carries significant consequences for aircrew. Complications range from distraction during flight to removal from flight status if symptoms are severe and persistent. The phenomenon of motion sickness is not new. It has been documented throughout history as plaguing travelers and militaries.[7] Despite this long history, methods for alleviation of symptoms vary greatly in effectiveness. Medications available to reduce symptoms are highly restricted in use for aviators due to safety risks associated with their side effects, leaving aircrew with limited options for relief. In rotary-wing aircraft, motion sickness is more problematic for passengers in the rear cabin; in military helicopters, these passengers may be soldiers whose level of readiness upon arrival to a combat destination may be reduced by motion sickness symptoms.[6] The intent of this study was to explore a novel approach to prevent motion sickness symptoms through the application of osteopathic manipulative techniques (OMT).

Motion sickness is widely accepted as a discrepancy between perceived and actual movement. The underlying mechanism is believed to be a disconnect between the communication of somatic/visceral, visual, and vestibular systems.[13] The resulting

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symptoms vary dramatically in presentation and severity. These include the more common symptoms such as nausea, vomiting, and fatigue (e.g., sleepiness), as well as decreased strength, coordination, and task performance.

Pharmaceutical options for prevention and alleviation of motion sickness are currently available both over the counter and by prescription. For pilots, these medications are dramatically limited or excluded for use before or during flight since most of them can cause significant drowsiness.[4] Army aviation uses various desensitization techniques to assist student pilots with acclimating to rotary wing stimulus and overcoming motion sickness.[12]

OMT may be a suitable supplement or replacement to pharmaceutical options for motion sickness prevention and symptom alleviation. OMT consists of manual manipulations performed by a licensed and trained physician that target neuromuscular and vasculature components that may be contributing to the negative symptoms of motion sickness, such as compressed nerves or arteries. Similar mechanisms have been proposed for the use of OMT for tension headache relief, where hypertrophy and asymmetry of the rectus capitis posterior major and obliquus capitis superior and inferior muscles compress the occipital nerve. The muscle energy technique and myofascial release are OMT methods that are believed to activate the Golgi tendon reflex, allowing for complete muscle relaxation.[1,2]

The purpose of this study was to examine the potential for OMT as an effective method for preventing motion sickness. A novel OMT protocol for the prevention of motion sickness symptoms was evaluated using a sham-controlled, counterbalanced, between-subjects study design. The independent variable was OMT treatment administered prior to the motion sickness inducing procedure (target treatment vs. sham treatment). The primary dependent measures were total and subscale scores from the Motion Sickness Assessment Questionnaire (MSAQ).

METHODS

Subjects

Participating in the study were 12 healthy adults, of which 5 were men and 7 were women. The mean age was 29.33 yr (SD = 5.57). All subjects were screened for medical history (e.g., vestibular disorders) or current use of medications/supplements that could bias their data or pose a safety risk. The study was reviewed and approved by the U.S. Army Medical Research and Development Command Institutional Review Board prior to conduct. Subjects provided written informed consent prior to study enrollment.

Procedure

Once determined to be eligible by a study physician, subjects first completed the Motion Sickness Susceptibility Questionnaire (MSSQ), a valid and reliable measure of one's propensity toward motion sickness symptoms.[8] Next, subjects received either the sham or target treatment, administered by a licensed osteopathic physician in a private room (to preserve blinding to the research team). The sham treatment did not include maneuvers that address the cervical region where the targeted anatomical structures are located. Instead, the sham maneuver treatment addressed soft tissue tension, restriction of motion, and tenderness of the lower thoracic and lumbar regions (**Appendix A** and **Appendix B**, found online at https://doi.org/10.3357/amhp.6248sd.2023). Subjects completed the MSAQ, a valid and reliable measure of the four dimensions of motion sickness: gastrointestinal (e.g., nausea); central (e.g., dizziness); peripheral (e.g., sweaty); and sopite-related (e.g., drowsy)[5] to gather a baseline. Subjects were seated and secured using the safety restraint in a Barany chair. The procedure to induce motion sickness symptoms mimics the protocol used by U.S. Army flight surgeons to desensitize aircrew susceptible to motion sickness (over repeated administrations; Program Director, Occupational Medicine Residency, School of Army Aviation Medicine; personal communication; July 12, 2022). Specifically, subjects were rotated (manually) at approximately 20 rpm for 10 min, with eyes closed, while varying the angle of their head to the ground.[11] Immediately following rotation, subjects completed a final MSAQ and were given adequate time to recover before release.

Statistical Analysis

All data was inspected for impossible values and technical errors prior to analysis. Difference scores (between pre- and postprocedure) were calculated for each MSAQ subscale (gastrointestinal, central, peripheral, and sopite-related) score and total score. Group differences in motion sickness susceptibility (MSSQ score) and age were evaluated with independent-samples *t*-tests. Group difference in gender was evaluated using a Chi-squared test of independence.

The effects of the treatment condition (target, sham) on the difference (from pre- to postprocedure) in MSAQ subscale (gastrointestinal, central, peripheral, and sopite-related) scores and total score (from pre- to postprocedure) were then evaluated using five separate between-subjects analyses of covariance (ANCOVAs).

RESULTS

Demographics of each group were evaluated in terms of comparability. Mean age for the sham group was 31.00 (SD = 5.78) and 27.67 (SD = 5.28) for the target group. The results of the independent-samples *t*-tests do not support any differences in age [$t(10) = 1.04$, $P = 0.32$ between groups]. With respect to motion sickness susceptibility, scores were comparable between the sham group (M = 12.15, SD = 10.51) and target group [M = 13.64, SD = 14.74; $t(10) = -0.20$, $P = 0.84$]. Gender was equally distributed across groups [$\chi^2(1, 12) = 0.34$, $P = 0.56$].

Summary statistics were calculated for all outcome variables (**Table I**). For the gastrointestinal subscale scores, there was a significant main effect of treatment condition such that scores

Table I. Summary Statistics for All Outcome Variables.

MEASURE	TIME	SHAM CONDITION MEAN (SE)	TARGET CONDITION MEAN (SE)
Gastrointestinal score	Pre	12.52 (0.69)	11.09 (7.49)
	Post	46.71 (7.49)	20.42 (7.49)
Central score	Pre	11.58 (0.49)	11.57 (0.49)
	Post	41.7 (7.95)	24.04 (7.95)
Peripheral score	Pre	11.11 (0.00)	11.11 (0.00)
	Post	42.89 (9.13)	36.74 (9.13)
Sopite-related score	Pre	12.96 (0.77)	11.58 (0.77)
	Post	26.08 (3.82)	12.81 (3.80)
Total score	Pre	12.16 (0.33)	11.33 (0.33)
	Post	39.33 (6.37)	22.71 (6.39)
Heart rate coefficient of variation	N/A	0.05 (0.02)	0.06 (0.03)

NA = not applicable; SE = standard error of the mean.

significantly increased in the sham group but not the treatment group [$F(1, 9) = 5.33$, $P = 0.04$] while controlling for MSSQ scores [$F(1, 9) = 6.15$, $P = 0.03$ (**Fig. 1**)].

For the central subscale scores, treatment condition did not significantly impact difference scores [$F(1, 9) = 2.49$, $P = 0.15$]. There was not a significant relationship between MSSQ scores and the difference in MSAQ central subscale scores [$F(1, 9) = 1.92$, $P = 0.20$].

Additionally, for the peripheral subscale scores, treatment condition did not significantly impact difference scores [$F(1, 9) = 0.23$, $P = 0.65$]. However, there was a significant positive relationship between MSSQ scores and the difference in MSAQ peripheral subscale scores [$F(1, 9) = 4.90$, $P = 0.05$].

The sopite-related subscale scores showed a significant main effect of treatment condition such that scores significantly increased in the sham group but not the treatment group [$F(1, 9) = 5.72$, $P = 0.04$ (**Fig. 2**)]. MSSQ scores did not correlate with the difference scores, suggesting that the treatment effect is not adjusted by one's motion sickness susceptibility [$F(1, 9) = 0.93$, $P = 0.36$].

For the total MSAQ scores, treatment condition did not significantly impact difference scores [$F(1, 9) = 3.13$, $P = 0.11$]. There was not a significant relationship between MSSQ scores and the difference in total MSAQ scores [$F(1, 9) = 3.72$, $P = 0.09$ (**Fig. 3**)].

DISCUSSION

The purpose of this preliminary study was to evaluate the efficacy of a novel OMT protocol to prevent motion sickness. While our findings show a reduction in reported symptoms across all four measured dimensions of motion sickness for the target treatment group in comparison to the sham group, the greatest difference was in gastrointestinal symptoms.

During the study, subjects in the sham group reported more severe gastrointestinal symptoms on the MSAQ than the treatment group. Within the sham treatment group, subjects reported high gastrointestinal symptoms on the MSAQ, including those in the group who reported not being susceptible to gastrointestinal upset on the MSSQ, apart from one subject who showed no change between the pre- and postexposure surveys. These results are of particular interest since nausea is the most commonly experienced symptom related to motion sickness.[9] Nausea, in motion sickness, is most commonly prevented pharmaceutically by antihistamines and high affinity muscarinic antagonists such as scopolamine, which both have strong sedative and potentially amnestic effects.[10] Conversely, side effects related to OMT are rare and most commonly present as bruising or soreness of the treated tissue.[3] Because of the impact of motion sickness on the aviation community and the lack of safe and effective treatment options available to military pilots, aircrew, and passengers, the results of this study showing improvement of nausea-related symptoms warrants further exploration.

The findings of this study regarding sopite-related symptoms leave room for interpretation. While the target group

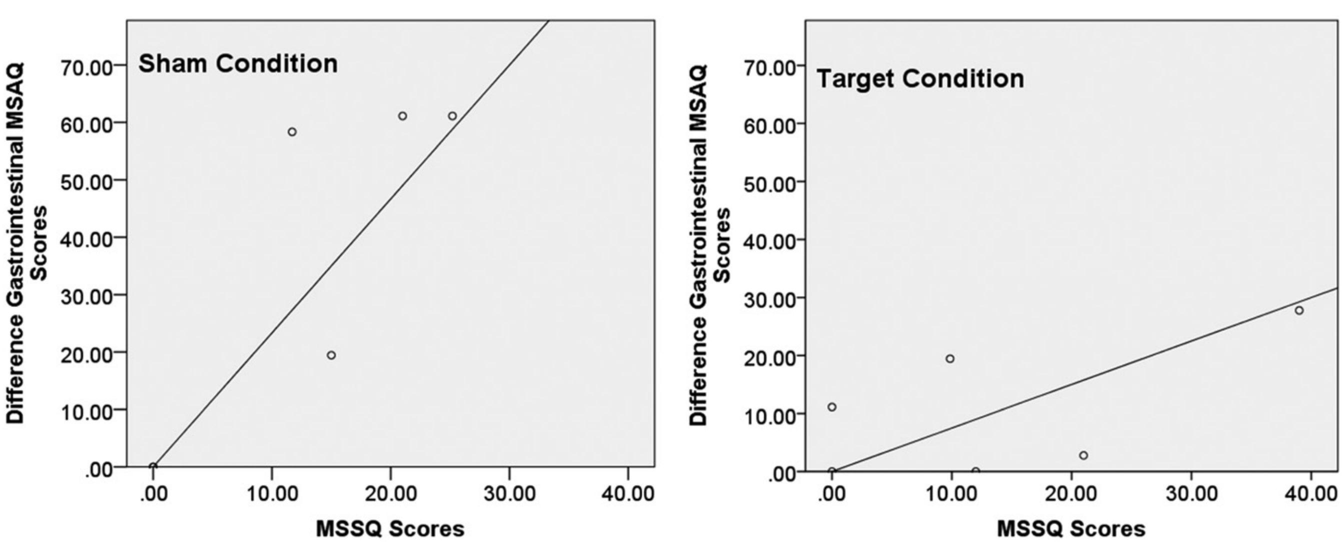

Fig. 1. Relationship between difference (pre- to postprocedure) in MSAQ gastrointestinal subscale scores and MSSQ scores by treatment condition.

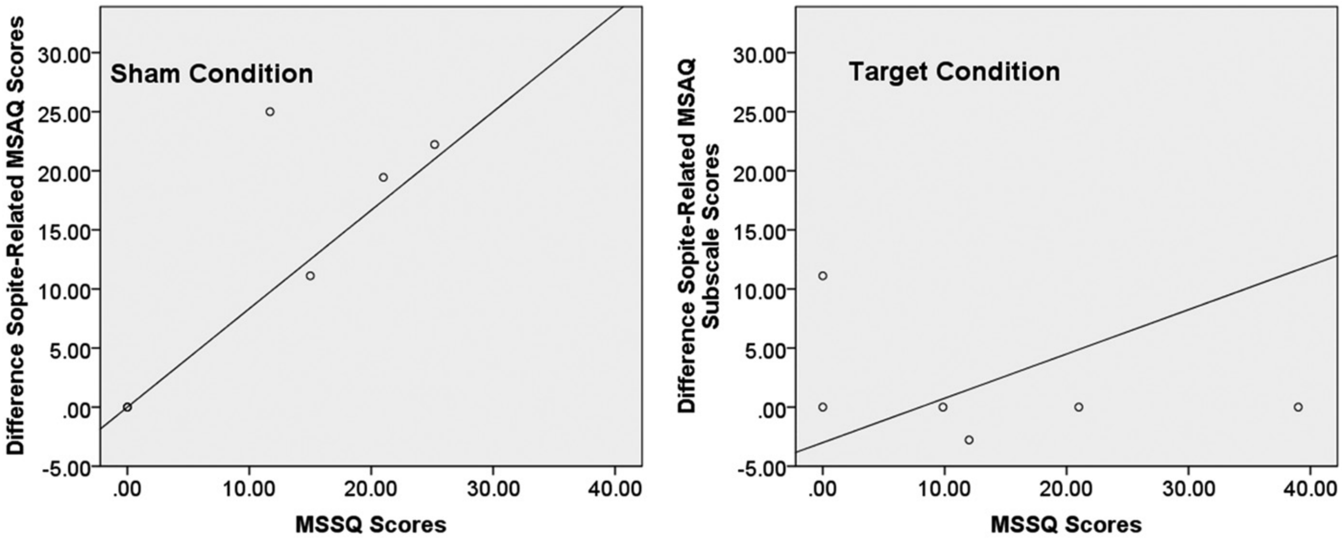

Fig. 2. Relationship between difference (pre- to postprocedure) in MSAQ sopite-related subscale scores and MSSQ scores by treatment condition. Negative score indicates lower value at post- than preprocedure.

experienced significantly fewer sopite-related symptoms than the sham group, we did not assess subjects' sleep activity for the night before testing to control for fatigue. Additionally, sopite-related symptoms can have a vague presentation, making them often overlooked in assessments of motion sickness.[9] While the results show promise, a more tailored study that takes multiple fatigue variables into account should be conducted to better observe the effects of OMT on sopite-related symptoms in motion sickness.

Neither central or peripheral symptoms subscales or total scores were significantly impacted by either the target or sham treatment. A more thorough assessment that included the extent to which subjects were susceptible to these symptoms may have assisted in interpretation of the results. Additionally, most subjects in both groups reported experiencing peripheral symptoms at a comparable level. Given that the total score is composed of the subscale scores, it is expected that no effect was seen. Further research to differentiate the effect of OMT on varying symptoms is warranted.

While this study showed promising results for the use of OMT to prevent motion sickness, it had many limitations that need to be addressed to better establish the effectiveness of the treatment. The study cohort was small, testing only 12 subjects—6 sham and 6 target. A larger population should be tested in order to evaluate gender and age differences, especially considering that the vestibular system changes with advancing age. To be considered for operational use in military aviation, the duration of the effects of treatment would need to be considered in future research as well, since flight times can last hours and our study only exposed subjects to 10 min of motion.

The results of this study were promising enough to warrant further investigation into the mechanisms of action of the

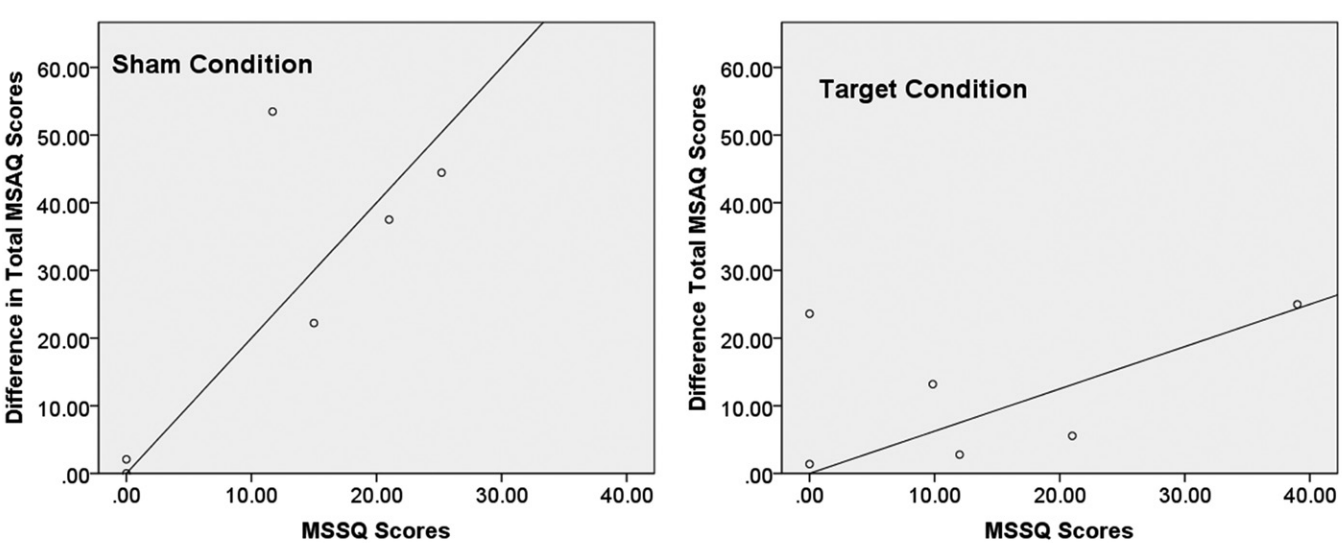

Fig. 3. Relationship between difference (pre- to postprocedure) in total MSAQ scores and MSSQ scores by treatment condition.

applied treatment. This may also help to elucidate why certain symptoms were more affected by treatment than others. Ultimately, the evidence shows potential for OMT to be used as a low-cost and (more importantly for aviation medicine) safe and effective preventive technique for motion sickness.

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