

Comfort and Preference during Prone Upper Thoracic Spinal Manipulation in Various Head Positions

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Additional Declarations: No competing interests reported.

Abstract

Background

Spinal manipulation therapy (SMT) is a recommended treatment for neck pain, including manipulation targeted at the thoracic spine. Predictors of positive outcomes from SMT have been suggested to include patient preference and patient comfort; however, few studies have investigated these characteristics in regard to how SMT is performed. The objective of this study was to examine the potential relationship between head rotation position during a prone upper thoracic hypothenar transverse push SMT procedure and patient preference and comfort.

Methods

An experimental cross-sectional design was used. Healthy adult volunteers received four SMT procedures to the upper thoracic spine, at various head rotation positions (neutral, 33%, 66%, 100% of maximal range of motion (ROM)). Overall rating and comfort of each position were measured with VAS and analyzed using Kruskal–Wallis rank-sum tests. Preference was analyzed with a Chi-squared test. Data collection took place between June to December of 2024.

Results

Ninety-one participants completed all study procedures and were included in the analysis (mean age 26.0 years $\pm$ 5.3; 43% female). Head position was significantly associated with preference ($\chi^2=16.5$, $p = 0.0009$) with 100% rotation being less preferred than neutral ($p = 0.0006$). Overall ratings showed that 100% was rated lower than neutral ($p = 0.0007$) and 33% rotation ($p = 0.042$). 66% ($p = 0.01$) and 100% ($p < 0.0001$) were rated less comfortable than neutral, and 100% was also less comfortable than 33% rotation ($p = 0.023$). Eight adverse events were reported (soreness/mild pain (7), 1 headache (1)).

Conclusion

Our results suggest head position influences reported preference and comfort during prone upper thoracic SMT. A better understanding of patient positioning on comfort and preference could provide guidance for improving teaching and the patient experience.

BACKGROUND

Neck pain is a common problem that most people experience at some point in their lifetime (Hoy et al 2010), with 203 million people affected globally in 2020, and an estimated increase of 32.5% between 2020–2050 (GBD 2021 Neck Pain Collaborators 2024). Spinal manipulation therapy (SMT) is a recommended treatment for neck pain, with benefits noted with SMT targeted at the thoracic spine

(Bussieres et al 2016, Cote et al 2016, Masaracchio et al 2019, Tsegay et al 2023). However, most of the research on SMT for neck pain has focused on clinical outcomes of pain, disability and range of motion (Bronfort et al 2004, Gevers-Montoro et al 2021), as well as the biomechanics of the spine during the procedure (Herzog 2010, Gyer et al 2022).

Patient comfort during SMT is not a well-researched area, but has been identified as an important prerequisite to performing SMT by both patients and practitioners (Gibbons and Tehan 2001, Wensley 2017, O'Donnell et al 2016), and has been associated with positive patient outcomes (Pasquier et al 2022).

Patient outcomes have also been linked to patient preferences, with those receiving care matched to their preferences showing greater improvement than those who did not (Hay et al 2008). Patient preferences is a key pillar of evidence-based practice models (Sackett 1997, Haynes 2002, Dusi et al 2023) and can influence care decisions. For example, when choosing a chiropractor or physiotherapist; patients particularly value technical competence (Bishop et al 2013). A previous study on comfort during side posture SMT suggested some people may prefer a particular setup position (Wang et al 2025), however the literature on patient preference for particular SMT procedures is very limited.

One type of SMT applied to the upper thoracic spine commonly used to treat people with neck pain is a prone hypothernar transverse push, that includes a head rotation setup position (Bergmann and Peterson 2011). A previous study on the hypothernar transverse push, demonstrated that those with more clinical experience apply SMT with an increased rate of force application, decreased time to peak, decreased peak force and a more consistent force direction (posterior to anterior, with a small component inferior to superior) (Triano et al 2011). However, the effect of head position on patient preference and comfort has yet to be studied.

This study examined the relationship between head position during a prone hypothernar transverse push SMT procedure and patient preference and comfort. Results from this study may inform students, teachers and field practitioners about the amount of head rotation needed to maximize comfort and better understand patient preference during a prone hypothernar transverse push procedure.

Hypothesis:

In healthy asymptomatic adults, the application of various head positions during an upper thoracic prone hypothernar transverse push SMT will result in significantly different levels of reported comfort and preference.

METHODS

Design

This study used an experimental, cross-sectional, within-subject design. This design was chosen due to its simplicity of detecting differences in comfort due to head position, where participants act as their own control through repeated-measures. The protocol for this study was prospectively registered on Open Science Framework on 2024-06-20. One modification was made to the data collection protocol after the initial design phase. Following initial protocol development and SMT procedural practice, the target force magnitude was increased from 550 N to 700 N (± 50 N) to better reflect what the researcher performing the SMTs typically used in clinical practice. Another change from the original protocol was analyzing data using a chi-square test instead of a one-way ANOVA to compare participant preferences across different head positions. This was because participants preference was measured as a binary outcome (Yes/No) rather than a continuous variable. When the overall chi-square test was statistically significant, post hoc pairwise comparisons of proportions were conducted using pairwise proportion tests with Bonferroni adjustment to control for inflated Type I error associated with multiple comparisons.

Participants were recruited by video advertisement on social media (Facebook), email announcements and direct recruitment (word of mouth) at the Canadian Memorial Chiropractic College (CMCC) campus clinic (Toronto, Canada) from June to November, 2024. This study was approved by the CMCC's Research Ethics Board (REB # 242003) and all participants provided electronic informed consent prior to participating in the study.

Setting and study participants

Data collection took place in the Force Sensing Table Technology (FSTT®) laboratory at CMCC, between June to December of 2024. Force-time profiles of each procedure were recorded to ensure consistent force application for all procedures. The FSTT® uses a chiropractic table with a built-in force plate (Netforce, AMTI, Watertown, MA, USA) to detect force-time characteristics at the patient-table interface, in all three axes (Fig. 1). The SMT force-time characteristics (e.g., peak force, time to peak) were captured using FSTT® software version 1.9 software (Canadian Memorial Chiropractic College, Toronto, Ontario Canada).

To participate in the study, inclusion criteria were adults greater than 18 years of age with no headache, neck or upper back pain on the day of collection. Exclusion criteria were treatment to the cervical or thoracic region in last 24 hours, currently on medications that alter pain perception (NSAIDs, opioids, antidepressants, etc.), current or recent arm/hand numbness, tingling, burning, pain or weakness (last 2 weeks), current or recent cervical, thoracic or shoulder fracture/trauma/pathology (last 2 months), surgery or injection to the cervical or upper thoracic region (last 2 months), recent night pain, fever/chills or night sweats (last 2 weeks), recent unexplained weight loss, infection or tumour of cervical or thoracic region (last 5 years), and reported pain during bilateral end range head rotation.

Order of head rotation position was not randomized in this study. From initial pilot data and anecdotal clinical experience with this SMT procedure, it was believed that increased head rotation could increase

the likelihood of cavitation, which could potentially influence comfort and preference ratings. For this reason, the order of head position was standardized starting in neutral and progressively increasing to maximal passive rotation, alternating left and right sides, for all participants. The initial target side (left or right) for the first procedure was randomly determined by coin flip (Tails = Left).

Study protocol

Upon arrival, Experimenter 1 (Exp1) asked participants to complete the electronic informed consent administered on Survey Monkey (SurveyMonkey Inc., San Mateo, CA, USA), with a tablet. Once completed, participants were assigned a unique study ID number and asked to complete the pre-procedure questionnaire that included age, sex, gender, height, weight, and if they had any previous experience receiving an upper thoracic prone hypothermic transverse push SMT procedure.

A digital angle inclinometer (KOEKA PT180), secured to an adjustable safety helmet strap, was used to measure head rotation (Fig. 1). Accuracy of the inclinometer was verified by comparison with a standard goniometer. Maximal passive head rotation ROM in prone position was determined by Experimenter 2 (Exp2) slowly rotating the participants head to the left and right, until the participant reported their maximum rotation was reached. Exp1 recorded the maximum rotation value and calculated 33% and 66% of maximum right and left rotations.

Exp1 flipped a coin to determine the initial target side (tails = left). A total of 4 SMT procedures were delivered to each participant, 2 on each side, in a single 20-minute data collection session. The following procedures for 33%, 66% and 100% head rotation were performed on alternating sides.

Exp2 located T2 transverse process (TVP) via palpation, skin slack (medial-lateral + inferior-superior direction) was taken up to position the contact hypothermic over the T2 TVP. The head was positioned at the pre-determined rotation angle and gently held with the support hand at the mastoid process. During the SMT procedure, Exp2 attempted to apply as little force on the head as possible to maintain the head position. The head was repositioned to neutral between each procedure. After each SMT procedure, Exp2 left the FSTT® lab and Exp1 gave the participant a tablet to complete the post procedure questionnaire.

The questionnaire included: overall rating of last procedure (VAS - left anchor: Did not like the procedure at all, Right anchor: Liked procedure very much), comfort/discomfort rating (VAS: 0 Unbearable discomfort, centre mark: neither comfortable nor uncomfortable, 100 Very comfortable), option to describe any reported discomfort, pressure felt on the head (VAS - Left anchor: No pressure, Right anchor: 100 Unbearable pressure), and the option to report any unfavourable procedures. On the final post-procedure questionnaire, the asked participants to choose the procedure(s) they preferred the most with an option to describe why.

Once each post-procedure questionnaire was completed, Exp2 re-entered the lab and repeated the above procedure at the next head rotation position and on the opposite side of the previous procedure.

Exp2 was a licensed chiropractor with 16 years of clinical experience and performed the SMT procedure, applying a consistent, pre-determined total peak force of 700 N (± 50 N). This force range was selected to reflect typical clinical practice by the manipulating researcher and falls within reported ranges from previous studies (Gorrell et al 2023).

There was a natural rest period (approximately 2 minutes) between each SMT procedure as the participant completed the post procedure survey.

Sample size calculation

The sample size calculation was based on pairwise comparison of comfort scores and overall ratings among the four head positions. For the six pairwise comparisons, an adjusted significance level of $\alpha = 0.008$, and statistical power of $1 - \beta = 0.80$ were used for the power and sample size calculation. A sample size of 79 participants was determined to be sufficient to detect an effect size of 0.4, representing a moderate effect according to Cohen's d classification (Cohen 1988).

Data analysis

Descriptive statistics were calculated for demographic variables, including means and standard deviations (SD). Mean and SD values for force-time characteristics were also computed.

Procedure comfort and overall rating (VAS scores) were analyzed using Kruskal–Wallis rank-sum tests. When the overall test was statistically significant, post hoc pairwise comparisons with Bonferroni adjustment (Armstrong 2014) were subsequently performed to control for inflated Type 1 error associated with multiple comparisons.

RESULTS

Ninety-three participants were recruited; two withdrew prior to completion (one due to discomfort with the instrument setup and one due to scheduling conflict), resulting in 91 participants included in the analysis (Fig. 2). Participant characteristics are presented in Table 1.

Table 1
Participant characteristics (n = 91)

Characteristics	Count
Sex	Female (39), Male (52)
Gender	Woman (40), Man (51)
Previous experience with prone upper thoracic SMT	Yes (84), No (7)
	mean (SD), min-max
Age (years)	26.0 (5.3), 21–56
Height (cm)	172.9 (10.2), 152–196
Mass (kg)	76.9 (15.1), 47.5–142.5

SMT (spinal manipulative therapy) SD (Standard Deviation), cm (centimeters), kg (kilograms)

Force-time characteristics were consistent across procedures, with a mean total peak force of 685.1 N (± 89.0). Mean reported head pressure increased with head rotation, from 17.5 (± 19.9) in neutral to 31.0 (± 22.1) at 100% rotation (Table 2).

Table 2
Force magnitude measurements and reported head pressure

Force-time characteristics	mean (SD)
Peak preload force (N)	386.53 (77.4)
Dip from preload to takeoff force (N)	1.52 (17.5)
Impulse peak force (N)	300.13 (73.0)
Total peak force (N)	685.11 (89.0)
Time to peak (ms)	168.73 (34.8)
Reported head pressure (VAS, 0 = no pressure, 100 = unbearable pressure)	mean (SD)
Neutral head position	17.5 (19.9)
33% rotation	22.9 (17.6)
66% rotation	25.1 (18.1)
100% rotation	31.0 (22.1)

N (Newtons of force), SD (Standard Deviation), ms (milliseconds), VAS (Visual Analog Scale).

Head position was associated with preference ($\chi^2 = 16.5$, $p = 0.0009$). Post hoc analysis indicated that 100% rotation was less frequently preferred than neutral ($p = 0.0007$) (Fig. 3).

Head position was also associated with comfort ($W = 21.4$, $p < 0.001$). Compared with neutral, comfort ratings were lower at 66% rotation ($p = 0.01$) and 100% rotation ($p < 0.0001$). Comfort at 100% rotation was also lower than at 33% rotation ($p = 0.023$) (Fig. 4).

Similarly, head position was associated with overall rating ($W = 16.6$, $p = 0.0008$). Ratings at 100% rotation were lower than neutral ($p = 0.0007$) and 33% rotation ($p = 0.042$) (Fig. 5).

Eight mild, transient adverse events were self-reported via post-procedure questionnaires, the day after collection, and consisted primarily of localized muscle soreness in the upper back and lower neck, including the upper trapezius and levator scapulae regions. One participant reported transient restriction in neck movement the following day, and one report of headache the following day. No adverse events required intervention.

DISCUSSION

This study investigated the influence of head rotation position on preference and comfort during a prone upper thoracic SMT procedure. The results indicate that increasing head rotation is associated with reduced comfort, lower overall ratings, and decreased preference.

Neutral head position was associated with the most positive responses across all outcomes. In contrast, maximal head rotation was consistently rated less comfortable, less preferred, and lower overall ratings. These findings suggest that greater head rotation may negatively influence the patient experience during this procedure.

Despite these overall trends, variability in preference was observed. A subset of participants preferred positioning involving greater amounts of head rotation. This finding highlights the potential importance of individual differences and supports consideration of patient preference when selecting setup positions.

Reported head pressure slightly increased with increasing head rotation. Although reported pressures were low, this trend may partially explain the reduction in comfort observed at higher rotation levels. However, the greater head rotation positions themselves could also explain the reduction in comfort and preference for some individuals.

These findings add to a limited body of literature examining patient experience during SMT. While prior work has focused primarily on biomechanical and clinical outcomes, the present results suggest that head positioning may have implications for both clinical practice and teaching. Modifying the head position for each individual during a prone upper thoracic SMT procedure, may improve comfort and accommodate personal preference. Given the emphasis on patient-centered care in manual therapy professions, consideration of comfort and preference may be clinically relevant.

Limitations

This study has several limitations. The sample consisted of young, asymptomatic individuals, which may limit generalizability to clinical populations. All procedures were performed by a single experienced practitioner, and only one technique was evaluated. The order of head position was not randomized, which introduces potential order effects that may have influenced preference and comfort ratings. Additionally, the applied SMT force used in this study may not reflect individual force preferences.

Future research

Future studies should examine these findings in symptomatic populations and across different SMT techniques and practitioners. The impact of preference and comfort on clinical outcomes (e.g., pain and disability) warrants further investigation. Additionally, the interactions between force–time characteristics, positioning, and preference should be explored.

CONCLUSION

Head rotation position was associated with differences in comfort, preference, and overall rating during a prone upper thoracic SMT procedure. Neutral positioning was associated with more positive responses, whereas maximal rotation was consistently rated as less preferred and less comfortable. These findings suggest that minimizing head rotation may improve the overall experience for some, although some individuals may prefer greater rotation.

Abbreviations

SMT
Spinal manipulation therapy
VAS
Visual Analog Scale
SD
standard deviation

Declarations

Ethics approval and consent to participate

This study was approved by the Research Ethics Board of the Canadian Memorial Chiropractic College (REB # 242003) and all participants provided written informed consent prior to participating in the study.

Consent for publication:

Not applicable. No individual person data included.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

None

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Author's Contributions

Simon Wang: Conceptualization, Methodology, Formal Analysis, Investigation, Resources, Data Curation, Writing – Original Draft, Visualization, Supervision, Project administration.

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Brooke Hildenbrand: Conceptualization, Formal Analysis, Investigation, Resources, Data Curation, Writing – Review & Editing, Project administration.

Malak Eid: Conceptualization, Formal Analysis, Investigation, Resources, Data Curation, Writing – Review & Editing, Project administration.

Steve Tran: Methodology, Investigation, Resources, Data Curation, Writing – Review & Editing, Project administration.

Nicole Smith: Conceptualization, Methodology, Formal Analysis, Investigation, Resources, Data Curation, Writing – Review & Editing, Project administration.

David Starmer: Conceptualization, Methodology, Resources, Writing – Review & Editing, Supervision, Project administration.

Martha Funabashi: Conceptualization, Methodology, Formal Analysis, Resources, Data Curation, Writing – Review & Editing, Supervision, Project administration.

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Trial registration on Open Science Framework

This study was preregistered prior to data collection on the Open Science Framework (OSF). The preregistration includes the study hypotheses, design, sampling plan, and statistical analysis plan. The registration is publicly accessible at: <https://archive.org/details/osf-registrations-gm3wf-v1>. Any deviations from the preregistered protocol are described in the manuscript.

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Figures



Figure 1
experimental setup

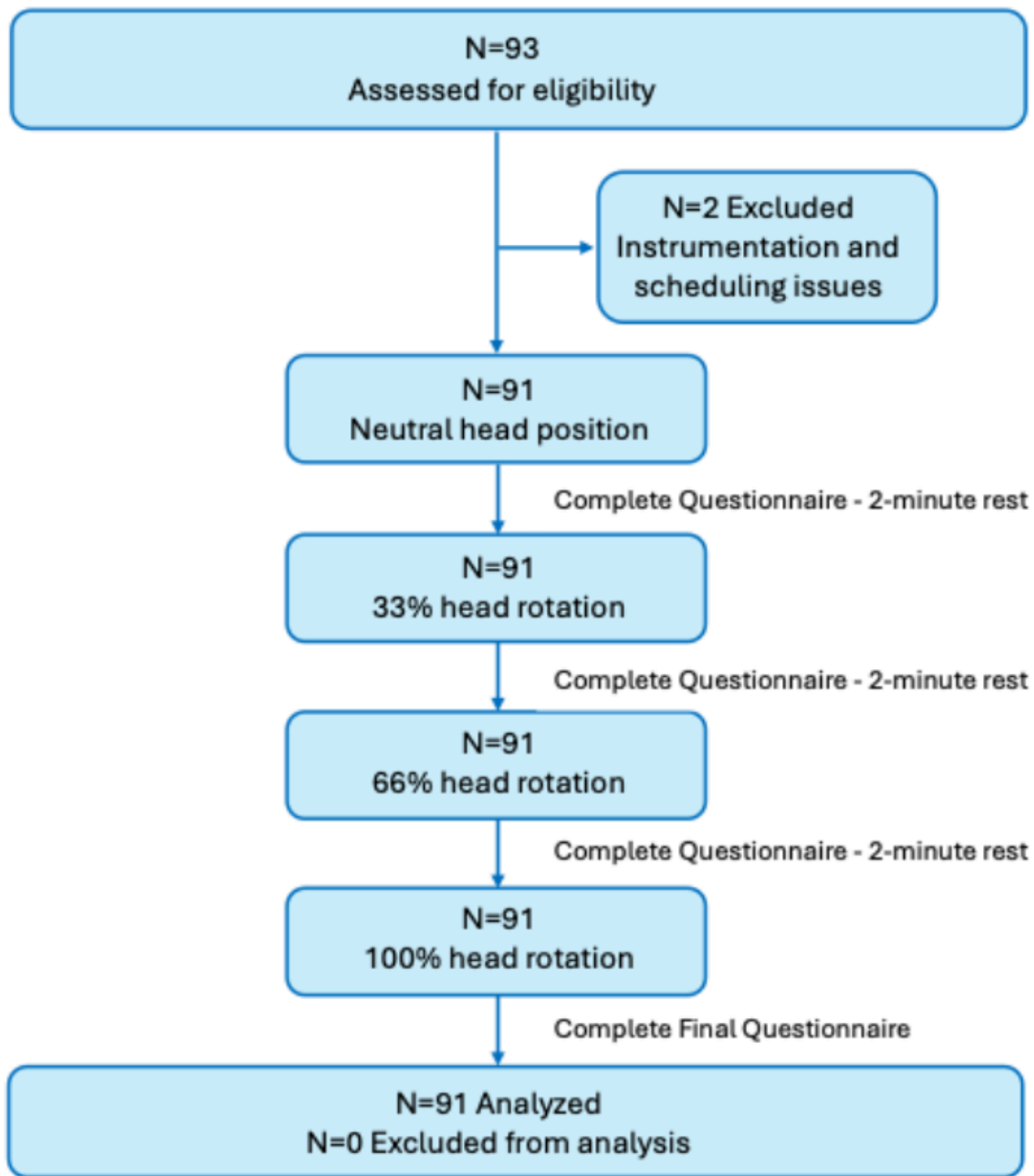


Figure 2

Participant flow chart

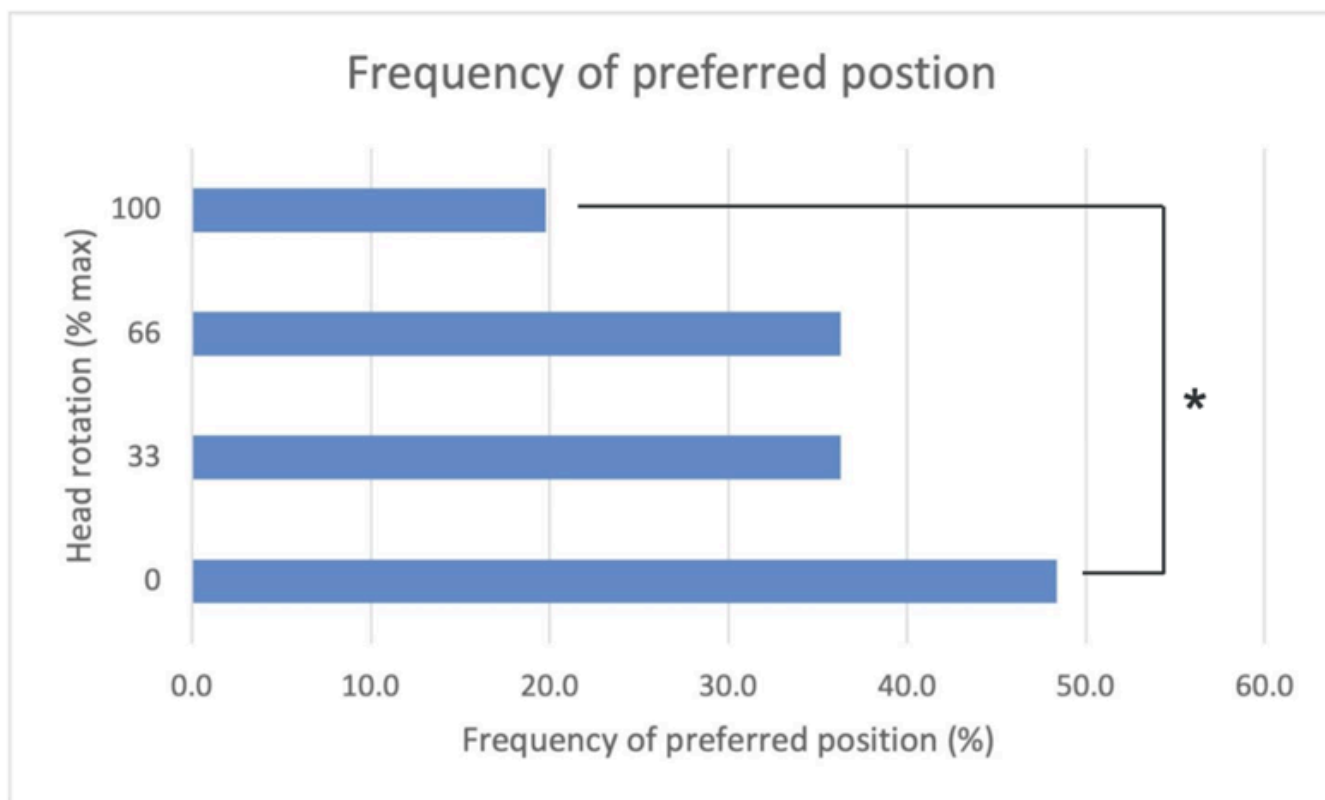


Figure 3

Percent frequency of reported preferred head rotation position. *Represents statistically significant difference between positions.

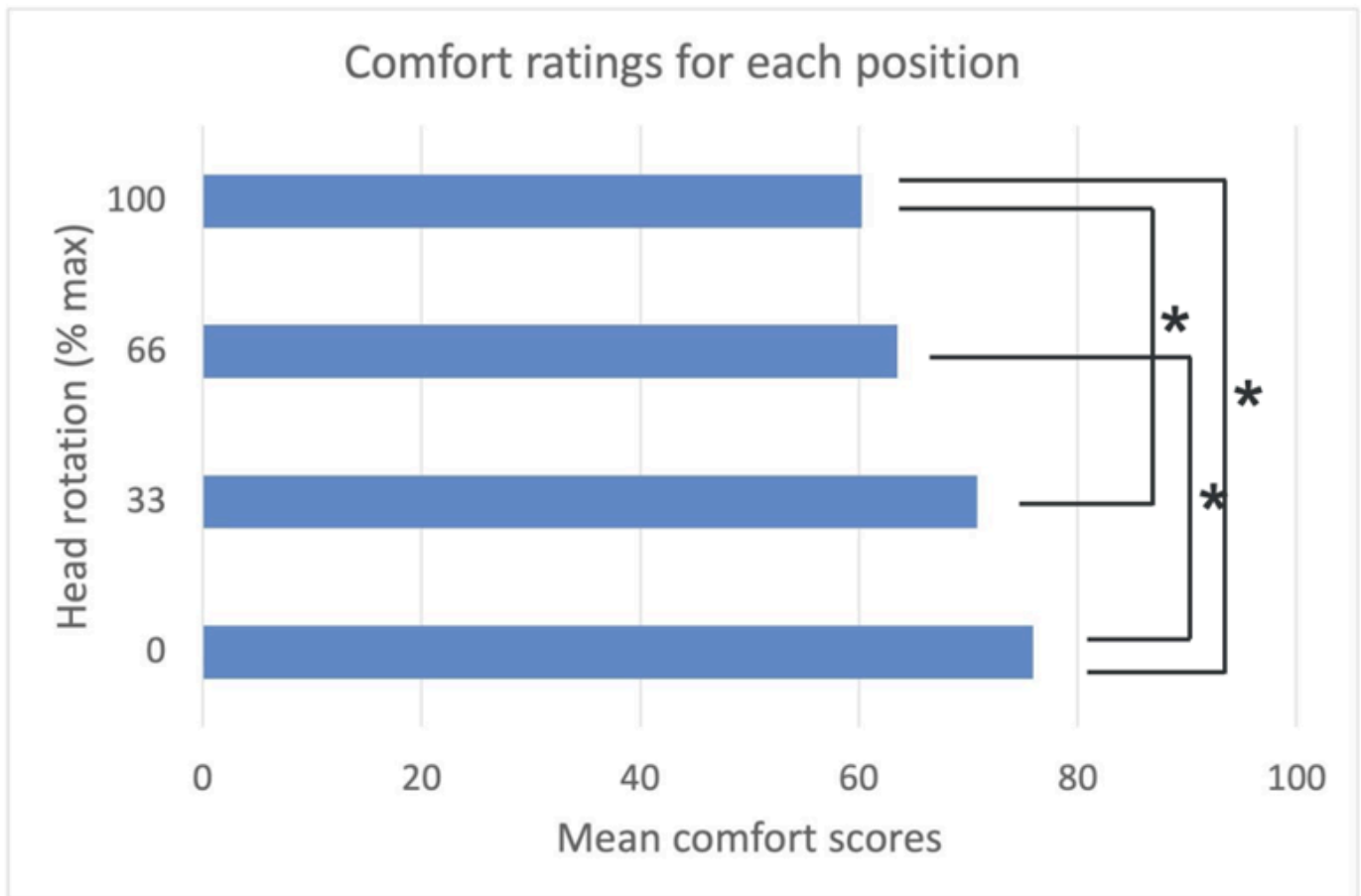


Figure 4

Mean comfort scores for each head rotation position. *Represents statistically significant difference between positions.

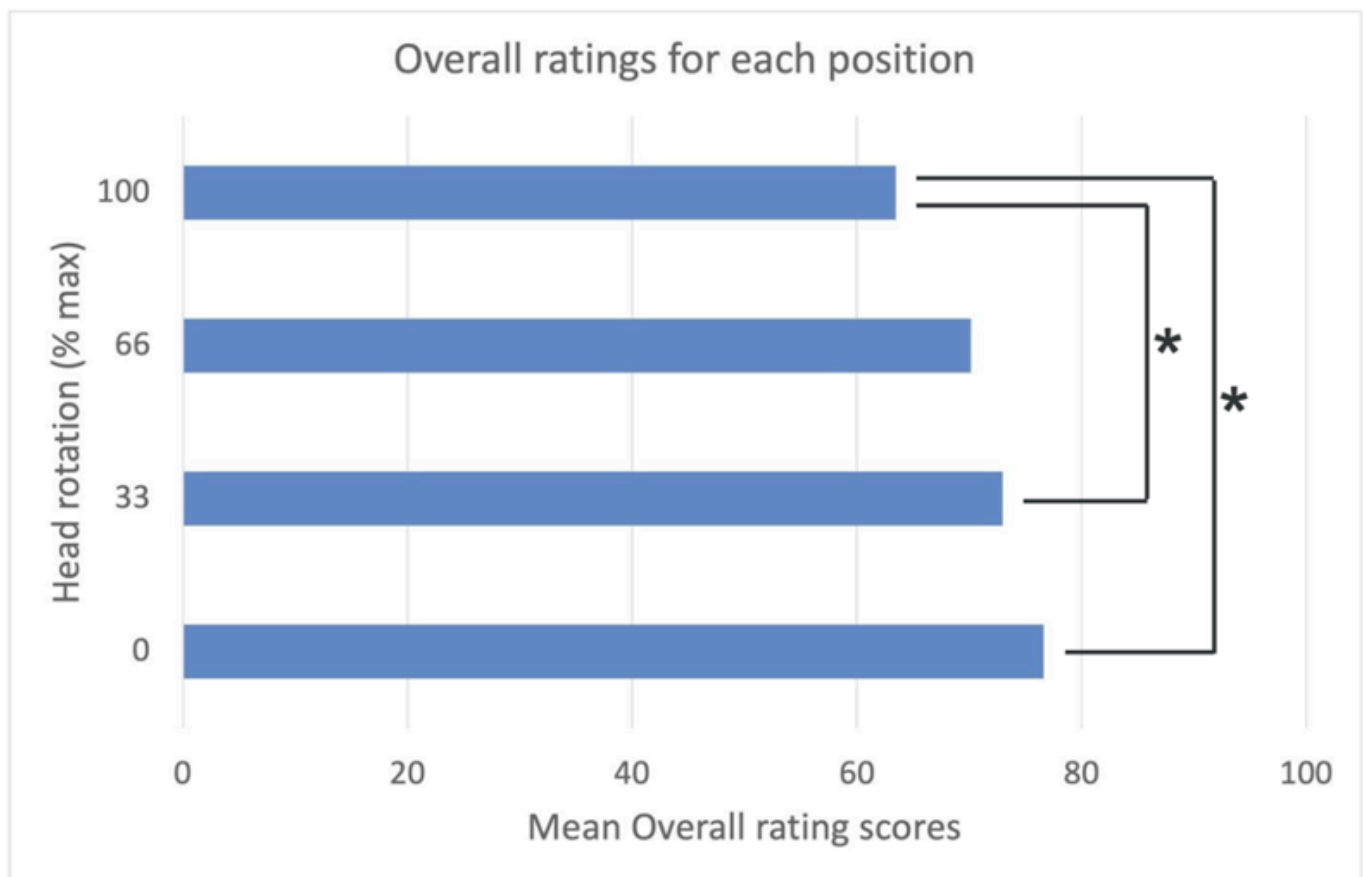


Figure 5

Mean overall rating scores for each head rotation position. *Represents statistically significant difference between positions.