Instrumentalists with asymmetric playing postures - Health issues, prevention, and physiotherapy

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Abstract

The objective of this study was to evaluate the use of specifically designed physiotherapy exercise program for musicians and K(inesio)®-Taping applications for violin, viola, and flute instrumentalists. Of thirty-six recruited musicians, 31 were advanced music students and five were professional musicians. The age ranged between 18 and 64, and there were 31 female and five male musicians. Musicians were randomly assigned into one of four groups: control group (CG), group receiving physiotherapy exercises intervention (PT), group receiving K(inesio)®-Taping intervention (KT) and group receiving both interventions (PK). The pre-/post intervention assessments included active cervical spine movements and pressure threshold of both upper trapezius muscles. The used questionnaires were German versions of Stress and Coping Inventar and Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians. Thirty-four participants (16 violin/viola ("high string") instrumentalists and 18 flute instrumentalists) completed the study, including pre- and post-assessments. Significance level was set at $p<0.05$. The results suggest that both interventions could provide ongoing support for specific musculoskeletal issues among instrumentalists, given the time commitment of the musician. This study highlighted some postural differences with varying effects between two instrumental groups and the urgent need to address / expand functional applied healthcare for musicians.

Introduction

Pertinent research in the field of performing arts medicine and performance science indicates musicians' risk of experiencing a range of health issues from an early age. The negative effects of non-ergonomic exposure while practicing repetitive movements, usually accompanied with increased muscle activity in often inadequate posture may stress the musculoskeletal system of a child (Ranelli et al, 2008), adolescent (Brandfonbrener, 2009), and adult musicians over time. International studies indicate that a lifetime prevalence of playing-related musculoskeletal issues among musicians ranges from 62% to 93% (Kok et al., 2015). If playing-related musculoskeletal health issues are not addressed and treated by health professionals, they could become chronic and result in a condition which might force a musician to pause or even stop performing (Guptill, 2012). The broad scientific literature emphasizes that specific health risks for a musician to experience musculoskeletal complaints depend on the individual, individual's posture and practice routines, physical activities, understanding the physical demands or psychosocial stressors, joint hyperlaxity, BMI, biomechanical flaws, gender, and the type of instrument played. Research shows that the type of the instrument is the most important factor in the relationship between gender and playing-related musculoskeletal disorders (PRMD) (Baadjou et al., 2016). Literature also indicates that violin, viola, and flute instrumentalists are at risk for developing musculoskeletal health issues due to their unbalanced body positions with elevated arms while playing the instrument. Interestingly, stage fright and female gender were proven predictors for developing playing-related pain (Steinmetz et al., 2014).

Experiencing playing-related musculoskeletal issues might start already from an early age. The research shows a high prevalence of pain and related issues around music performance in child instrumentalists (Ranelli et al, 2011; Nawrocka et al, 2014) which, if not treated might negatively influence the ensuing musical progress. The international research reveals that freshmen music students enter the tertiary university program with a history of pain or a playing-related musculoskeletal injury with its origin in their childhood (Spahn et al, 2004; Brandfonbrener, 2009) and that musician's general physical activity might not be as functional because of high prevalence of musculoskeletal issues compared to their peers studying other subjects (Ballenberger et al, 2023). The disheartening fact is that between 82% and 97% of orchestra musicians report an injury in connection with playing music over a one-year period, and the full recovery is to be expected in less than 50% of injured musicians (Ackermann et al, 2012).

In case of the body regions affected by PRMD in classical musicians, the literature demonstrates that the spine is the most frequently affected and string instrumentalists more often suffer from PRMD in comparison to the wind, percussion, piano, singing and musical groups (Zalpour et al., 2021). There is evidence that high-string (violin and viola) instrumentalists are more likely to develop PRMD than low strings (Nyman et al., 2007). Due to their specific required unnatural posture and high demands on the musculoskeletal system, the most affected areas for violin and viola instrumentalists are the shoulder-neck region (Nyman et al., 2007; Kok et al., 2015; Stanek et al., 2017; Kochem & Silva, 2018), back (Abréu-Ramos & Micheo, 2007), right elbow and hand, as well as left hand fingers (Lahme et al., 2014). The literature also shows consistency of high prevalence of musculoskeletal problems concerning flute instrumentalists at the neck, middle/upper back, shoulders, upper extremities, and wrists and hands (Spence, 2001; Ackermann et al., 2011; Lonsdale et al., 2014).

These findings show that health issues and playing-related musculoskeletal issues are common at all levels of music performance. Beside the goals like continuing health education of teachers and their students (Ackermann et al, 2024), an urgent task for all professionals accompanying the musicians is a development of functional applied healthcare for musicians in sense of prevention and rehabilitation of musculoskeletal health issues at all levels of music performing.

Aims

The objective of this study was to examine the efficacy of two non-invasive physiotherapy interventions for musicians who play the flute or violin/viola (high strings) for a minimum of seven hours per week and have exhibited musculoskeletal symptoms, including muscle tension, fatigue, or pain, prior to the begin of the study. The physiotherapy interventions were exercises specifically designed for musicians (Chan et al., 2014) (Fig. 1a) and the implementation of K(inesio)®-Taping applications (Kumbrink, 2011) (Fig. 1b).

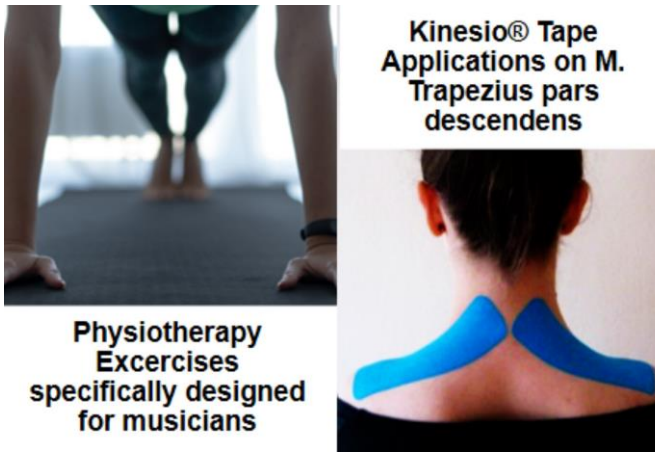

Figure 1a & 1b. Overview of the physiotherapy interventions

The following hypotheses were formulated based on the study design:

1.) Functional Mobility Performance Hypothesis: Both PT and KT interventions will significantly improve cervical spine mobility, as measured by the Noraxon® 3D motion capture system.

2.) Pain Threshold Hypothesis: Participants receiving PT or KT interventions will demonstrate a significant increase in pressure pain tolerance at trigger points in the trapezius muscles compared to the control group.

3.) Subjective Pain Hypothesis: Both interventions will lead to a significant reduction in subjectively reported musculoskeletal pain, as assessed by the Visual Analogue Scale (VAS) and the Body Chart.

Methods

The study's methodology comprised a pre-post, between-subjects, repeated-measures design. All participants were informed about the study methods and interventions. Participants signed the consent form with the option to withdraw from the study at any time without facing any negative consequences. The participants voluntarily engaged in data collection and weekly interventions without receiving compensation.

Participants

Five professional musicians residing in Austria and 31 advanced music students enrolled at four different Austrian universities were randomly assigned to one of four research groups: The Control Group without interventions (CG=**9**♀), the Physiotherapy exercises intervention group (PT=**7**♀/**2**♂), the K(inesio)®-Taping intervention group (KT=**8**♀), the group with both interventions (PK=**7**♀/**3**♂). It should be noted that there was one dropout from CG and one dropout from PT group during the beginning of the intervention weeks period (Fig. 2).

Table 1. Age characteristics of the 34 participants who completed the study

	N	*M*	*SD*	*Min*	*Max*
CG	8	25.9	7.90	21	45
PT	8	33	16.6	18	64
KT	8	25.9	10.6	20	52
PK	10	23.8	4.08	19	33

Questionnaires

Prior to the beginning of the initial measurements, the participants completed a questionnaire designed to elicit health-related information, personal data, and supplementary music-related information.

The questionnaire was developed in German and was modeled after the German version of the Musculoskeletal Pain and Intensity and Interference Questionnaire for Musicians (MPIIQM-G) (Möller et al., 2018) and a specific part of Stress- and Coping Inventar (SCI) (Satow, 2012). The questionnaire also collected additional data regarding instruments and practice routines. Pain intensity and interference were assessed using a Visual-Analogue-Scale (VAS) and a Body Chart. Stress and coping outcomes were assessed with a SCI.

Measurements

The physical examinations were conducted at the Motion-Emotion-Lab (MEL) of the Centre for Music Physiology (Dep. 13) at the University of Music and Performing Arts Vienna. Initial evaluation measures were taken prior to the commencement of the study (T1), which was followed by a ten-week intervention phase during which the intervention groups underwent physiotherapy exercises and/or K(inesio)®-Taping. Following the conclusion of the intervention phase, a final evaluation was conducted (T2) to ascertain the efficacy of the therapeutic approach.

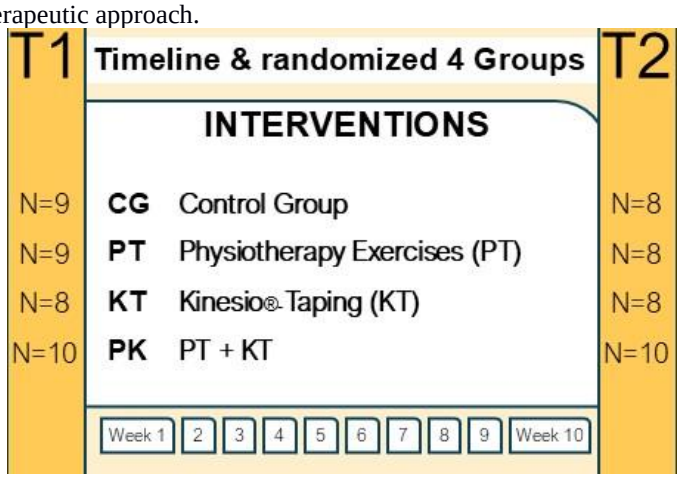

Figure 2. Timeline and the research groups overview

The pre-/post intervention assessments included visual and palpatory upper body inspection, active cervical spine movements and pressure/pain threshold at two selected trigger points on the left and right upper trapezius muscles.

Visual postural analysis (Fig. 3a) involved a visual inspection of the upper body and a palpable inspection of the shoulder blades which included Spina scapulae (1,2), the Angulus inferior Scapulae (3,4) and Acromion.

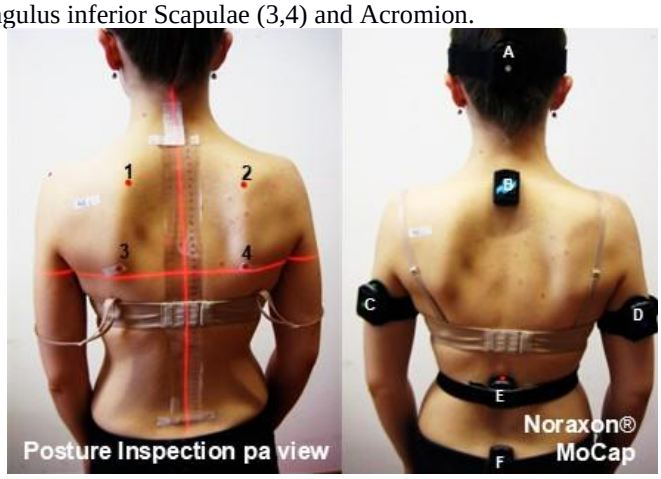

Figure 3a & 3b. On the left is the posture inspection in pa view and on the right the Noraxon® Motion Capture (MoCap) set up

Skin-friendly medical surgical tape (3M) was meticulously applied at the Angulus inferior scapulae. Three round-shaped colored body markers were strategically positioned at the medial start of the Spina scapulae, which ends laterally at the Acromion and caudally at the Angulus inferior, the lowermost end of the shoulder blade. Photographs were meticulously documented digitally in the posterior-anterior (pa) view to facilitate a comprehensive posture aesthetics analysis.

The assessment tool for pressure tolerance, measured on two bilateral trigger points (TRGP) of the upper trapezius muscles, was a digital Wagner algometer (Fig. 4). The result of each TRGP was a mean of three measured outcomes.

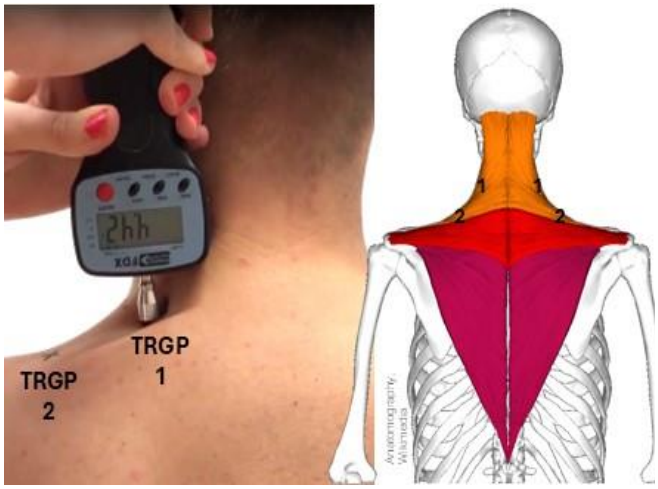

Figure 4. The Wagner algometer and the upper trapezius TRGP

The mobility of the cervical spine was assessed using a Noraxon® 3D biomechanical motion capture (MoCap) analysis system (Fig. 3b and Fig. 5). The sensors (Fig. 3b) on the head (A) and both upper arm areas (C, D) were embedded in Noraxon® sensor housing and fixed with a Noraxon® sensor stripe. Prior to the application of the double adhesive tape, the cervical-thoracic junction (B), the thoracic-lumbar junction (E), and the end of the lumbar spine (F) were meticulously sanitized. The double adhesive tape was then affixed, with one side adhering to the remaining sensors and the other side to the prepared skin. The thoracic-lumbar junction (E) was secured with a Noraxon® sensor stripe. The complete session of movements of the cervical spine (Fig. 5) includes flexion-extension (row 1), left and right lateral flexion (row 2), and left and right rotation (row 3).

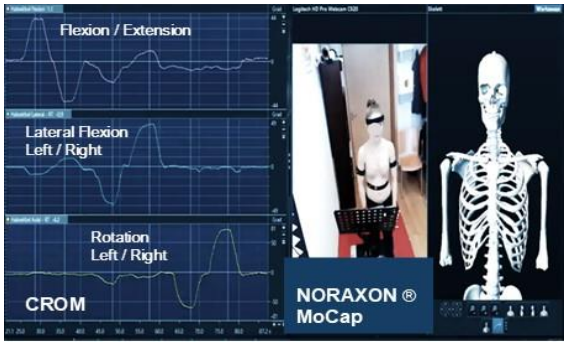

Figure 5. Cervical range of motion (CROM) examination

Data Analysis

Initial (T1) and final (T2) examination data were analyzed using the open-source statistical program jamovi 2.3.28, with a significance level α set at 0.05. The null hypothesis was rejected if $p < 0.05$. Differences over time within each group were measured using paired *t*-tests, while changes over time for all four research groups and two instrumental groups were measured using repeated measures ANOVA. The correlation between pain intensity, pain interference, stress and sleep were measured with a correlation analysis.

Results

While the results of the pain intensity between the examination points over time remained statistically unchanged, the Body-Charts reports indicated a non-significant reduction in some reported areas at the final examination time point T2.

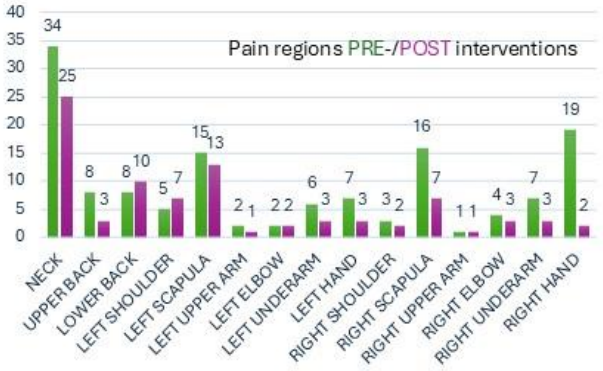

Figure 6. Affected pain regions pre-/post interventions

The prevalence of pain was reported in various anatomical regions. To facilitate the presentation of these data, the locations are grouped into the following categories: neck, upper/lower back, left/right shoulder, left/right scapula, left/right upper arm, left/right elbow, left/right underarm, and left/right hand (Fig. 6). The subjective pain areas reported in this study correspond with the international research findings previously mentioned in the Introduction. The neck was the most frequently marked region, a finding that aligns with existing literature on the subject.

A paired *t*-test was employed for each group, with the objective being to ascertain the extent to which a given variable has changed within the group from the initial time point (T1) to the respective values at the final time point (T2). The findings of the paired *t*-test demonstrate significant alterations in pressure/pain tolerance at the designated TRGP within the PT and PK groups. The PT group exhibited a notable increase in pressure tolerance at the TRGP1 left (t = -2.8224, df = 7, $p = 0.026$), TRGP2 left (t = -3.09, df = 7, $p = 0.018$) and TRGP2 right (t = -2.426, df = 7, $p = 0.046$). In contrast, the PK group demonstrated a significant increase in pressure tolerance at the TRGP1 left (t = -3.828, df = 9, $p = 0.004$) and TRGP1 right (t = -5.107, df = 9, $p < 0.001$), as well as at TRGP2 left (t = 4.767, df = 9, $p = 0.001$) and TRGP2 right (t = -4.9062, df = 9, $p < 0.001$). No significant changes were observed in the CG and KT groups.

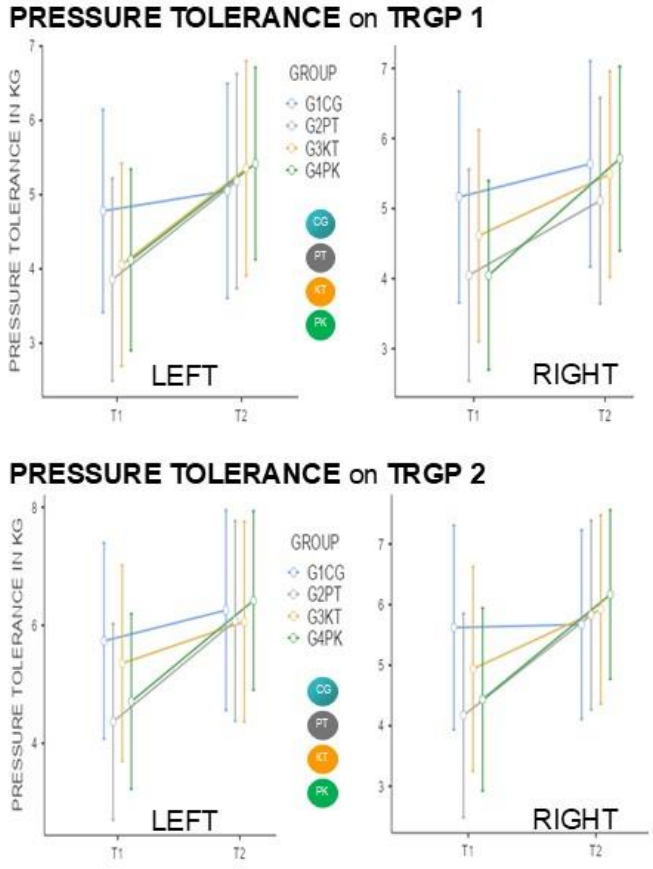

Figure 7a & 7b. Pressure tolerance graphic rm ANOVA results

The results of the paired *t*-test show significant changes regarding certain cervical spine functional movements only in the KT group (Fig. 8), which correlates with ROM increase from the literature (Karatas et al., 2011). A significant increase in KT group was observed in head flexion (t = -2.574, df = 7, $p = 0.0037$), left lateral flexion (t = -3.535, df = 7, $p = 0.01$), and left rotation (t = -3.125, df = 7, $p = 0.017$) movements.

The findings of the rm ANOVA indicate a significant main effect of the examination time on all trigger points (Fig. 7): TRGP1 left (F = 20.45, df = 1/30. $p < 0.001$), TRGP1 right (F = 12.541, df = 1/30, $p = 0.001$), TRGP2 left (F = 17.72, df = 1/30, $p < 0.001$), TRGP2 right (F = 13.51, df = 1/30, $p < 0.001$). The interactions in the intervention groups and the main effect of the group were not significant; however, the post-hoc tests revealed a statistically significant increase in pressure/pain tolerance at the time point T2 in flute instrumentalists; TRGP1 left (t = -4.129, df = 32, *p_tukey* = 0.001), TRGP1 right (t = -3.43, df = 32, *p_tukey* = 0.009), TRGP2 left (t = -4.897, df = 32, *p_tukey* < 0.001), TRGP2 right (t = -4,178, df = 32, *p_tukey* = 0.001). The post-hoc test results demonstrated no statistically significant alterations for the high-string instrumentalists (Fig. 9).

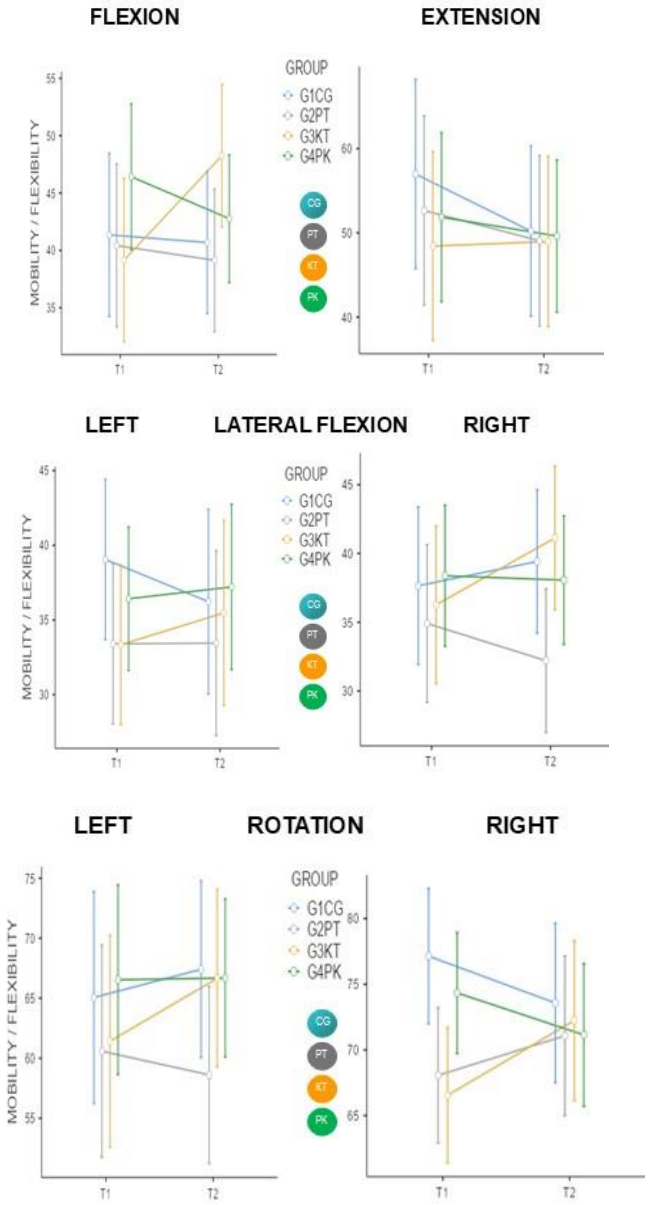

Figure 8a, 8b & 8c. CROM graphic rm ANOVA results

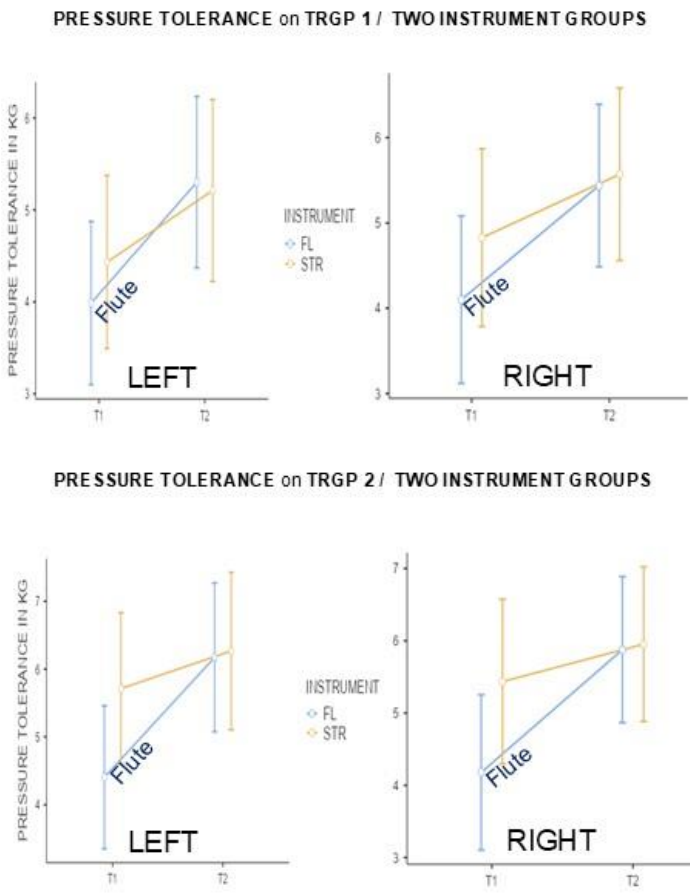

Figure 9a & 9b. Significant increase in pressure tolerance on trigger points in flute instrumentalists - rm ANOVA graphic

Pearson's correlation analysis demonstrated a significant negative correlation between stress and average hours of sleep ($r = -0.685$, $df = 32$, $p < 0.001$). Pearson's correlation further revealed a significant positive association between stress and pain intensity ($r = 0.356$, $df = 31$, $p = 0.042$) and stress and interference ($r = 0.352$, $df = 31$, $p = 0.045$).

The influence of age on pressure tolerance and cervical range of motion (CROM) was found to be statistically significant. Specifically, younger musicians exhibited higher values for CROM and lower values for pressure tolerance.

The personal written feedback on KT reveals positive effects and recommendations for using the applications.

Discussion

The findings indicate that physiotherapy exercises specifically designed for musicians and applied K(inesio)®-Taping on trapezius muscles effectively enhance pressure/pain tolerance on trigger-points, underscoring their potential as non-invasive interventions for playing-related musculoskeletal health issues in flute, violin/viola instrumentalists. Future studies should investigate the long-term effects of these interventions and explore their use across diverse instrumentalist populations to further validate their efficacy.

Conclusion

The implementation of physiotherapy exercises (PT) and K(inesio)® Taping (KT) interventions were met with enthusiasm and demonstrated significant benefits. The hypotheses of the study were partially or fully confirmed: specifically, physiotherapy exercises intervention was found to result in a quantifiable increase in pressure/pain tolerance at trapezius trigger points, a finding that was particularly evident among the PT and PK groups. This observation serves to validate the efficacy of PT in mitigating playing-related musculoskeletal issues. Conversely, KT exhibited substantial enhancements in cervical spine mobility, encompassing head flexion, left lateral flexion, and left rotation, thereby partially validating its application in addressing the functional mobility of the cervical spine. However, the study did not fully confirm the hypothesis that both interventions would significantly reduce subjectively reported pain, as changes in pain intensity over time on reported areas were not statistically significant. These findings underscore the efficacy of both interventions as non-invasive instruments for the prevention and management of playing-related musculoskeletal disorders (PRMD) in flute, violin/viola instrumentalists. Their incorporation into regular practice routines could assist in enhancing overall musculoskeletal health, with the potential for long-term application in rehabilitation processes for musicians.

Limitations

While the overall sample size met the lower acceptable limit for this study's scope, dividing the participants into four subgroups increased the complexity of the study design and limited the statistical power of subgroup comparisons. Nevertheless, the comparison of two distinct methods (PT and KT) provided valuable insights, even with smaller sample sizes per group. Due to the overall small sample size, an outlier in the control group (CG) remained in the data analyses. The reliance on self-reported pain and stress data introduces the potential for subjective bias, and the lack of long-term follow-up precludes conclusions about the sustained effects of the interventions. Despite the use of advanced measurement tools, minor variations in device handling or environmental factors could have influenced the results.

Ethics

The Ethics Board of the University of Music and Performing Arts Vienna granted the approval for this pilot study.

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