The effect of short-term mindfulness focused attention meditation on pain sensitivity

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Abstract

Studies show that long-term mindfulness meditation provides the ability to enhance a broad spectrum of cognitive health outcomes on chronic pain patients. However, there are not many studies which show the effect of short-term mindfulness on chronic neck pain. The purpose of this study was to determine if short-term mindfulness focused attention meditation can alter pain sensitivity. Pressure pain was applied with an algometer in two measurement sessions on the right upper trapezius in healthy subjects with 5 days in between. Whereby pressure pain threshold and pressure pain tolerance were evaluated. The treatment group practiced 20 minutes of mindfulness focused attention meditation on 5 consecutive days between the two measurements, whilst the control group continued their normal routine. Results showed no significant improvement of pressure pain threshold and pressure pain tolerance. Moreover, no significant difference in improvement of threshold and tolerance was found. Nevertheless this study still contributes to the field of pain relief using mindfulness meditation. Since this study shows the tendency that mindfulness focused attention meditation increases both, threshold and tolerance, a longer period of practicing mindfulness focused attention meditation should be investigated.

I. Introduction

Approximately 20 % of the world population suffer from chronic pain [1]. The characteristic of chronic pain is a duration of pain more than three months [2]. Due to the persistence of pain the patients get restricted physically as well as psychically. The patients' ability to participate in diverse activities decreases. Those activities are not only physically but also socially, maintaining an independent lifestyle and relationships to friends and family can be affected. A survey in nine European contries by Breivik et al. [3] showed that pain has an impact on the work life, whereby 25% of the patients indicated that they changed their job, responsibilities at job or lost their job due to chronic pain. Furthermore, depression was diagnosed in 21 % of those patients. [3]

One of the most common types of chronic pain is neck pain, as 25 % suffer from this in the UK [1]. Those patients are restricted by negatively affected fatigue and concentration [4]. Furthermore, they suffer like the majority of chronic pain patients from anxiety and depressed mood, cognitive distress and the resulting physical limitations. [5]

At the moment there is no cure for chronic pain. The current treatment methods only provide possibilities to relieve the pain. [6, 7] Nevertheless, the majority of the patients feels pain daily and this pain increases throughout the day due to the daily activities. [3] Chronic pain is mainly treated by medication. However, medications have side effects like abuse or organ damage. To avoid those risks, alternative methods can be used. One of those methods is mindfulness meditation. Whereby meditation is used as mental training to achieve diminished judgment of emotions, cognitive control and existential insight. [7] One of the

most common types of meditation techniques is focused attention (FA), which trains the concentration by focusing on an object or specific thing, often the sensation of breath [**?**].

Previous studies show that mindfulness meditation provides the ability to enhance a broad spectrum of cognitive health outcomes. Furthermore stress, depression and anxiety can be relieved. These improvements are due to practicing mindfulness meditation, especially because of the mental training in emotion regulation, cognitive control, acceptance and positive mood. [7, 8] Nevertheless, there are not many studies which show the effect of mindfulness meditation on chronic neck pain. [1] Additionally, the pain relieve properties are mostly investigated after practicing mindfulness meditation over a time period of two months or more. The effect of a shorter time period of mindfulness meditation on chronic neck pain is not investigated yet.

The present study address if mindfulness FA meditation can alter pain sensation in the neck by measuring pressure pain threshold and pressure pain tolerance before and after short-term mindfulness meditation. Therefore the hypothesis "Short-term mindfulness FA meditation increases the pressure pain threshold and the pressure pain tolerance in the upper trapezius" was tested.

The upper trapezius is involved in chronic neck pain, hereby was chosen as testing point for pressure application [**?**]. Furthermore this muscle present lower pressure pain threshold values compared with other muscles[**?**].

II. Methods

i. Subjects

42 healthy subjects, 21 female and 21 male were recruited (age: 23.93 $\pm$ 2.74 years, BMI: 23.66 $\pm$ 3.28). Subjects with ongoing meditation practice, acute or chronic pain, neurological, musculoskeletal or mental illness, pregnancy or taking medications that might influence their response to pain were excluded.

ii. Study design

A controlled trial was designed, whereby the subjects were assigned into a control and treatment group with an equal gender distribution, as illustrated in Figure I.

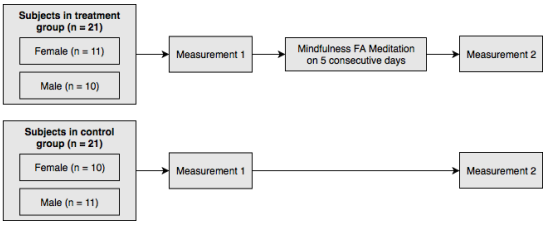

Figure I: *Parallel study design, whereby subjects were assigned to treatment and control group, striving an equal gender distribution. The treatment group was meditating on 5 consecutive days between the measurements, whilst the control group continued their normal routine.*

The subjects of the treatment group practiced 20 minutes mindfulness FA meditation on 5 consecutive days between the two measurements, while the subjects of the control group continued their normal routine. The same time interval between the measurements was used for the two groups.

iii. Measurements

The testing point, as shown in Figure II, was marked at the right upper trapezius to ensure reliable and rapid location during the experimental procedure. The location of the testing point on the right upper trapezius was determined between the acromion and 7th cervical vertebra.

Pressure pain threshold and pressure pain tolerance were measured with an algometer (Wagner Force Ten^{TM} Digital force Gage) three repetitions with a 5 minutes resting period in between. The examiner was blinded during the measurements to avoid bias. The mean of the three repetitions, was computed.

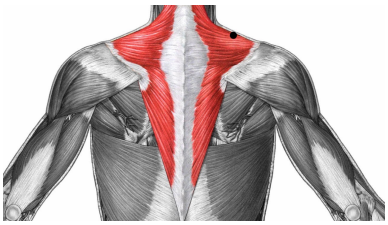

Figure II: *Testing point on the right upper trapezius.*

iv. Meditation Technique

Short-term mindfulness FA meditation with 20 minutes of meditation practice on 5 consecutive days. To ensure same meditation conditions, a guided meditation in form of an audio file was used.

A short introduction to mindfulness FA meditation was provided before the first meditation session. The used meditation technique was focused attention focusing on breath flow.

v. Data Analysis

At first the normality of the data sample was evaluated with a Shapiro-Wilk test and the equality of variances was evaluated with a Levene's test.

According to the outcome of the Shapiro-Wilk test and the Levene's test, ANOVA and t-test were chosen. The two-way mixed ANOVA was used, whereby factor 1 denotes the group of subjects, either treatment or control, and factor 2 denotes the measurement session, either the first (Pre) or the second (Post). Therewith the statistical significance of two variations was evaluated, the between-subjects variation in factor 1 and the within-subjects variation in factor 2. [**?**] Threshold and tolerance have been analyzed with separate two-way mixed ANOVAs.

The t-test was used to compare the changes in threshold and tolerance between the measurement sessions of treatment and control group. Therefore the relative difference (Improvement) in threshold and tolerance between Pre and Post was calculated for each subject. Then a t-test was applied to the Improvements to test the mean difference between treatment and control group's Improvement. [**?**] Threshold and tolerance Improvements have been analyzed separately.

III. Results

The tolerance for some of the subjects is not representative, as the examiner was not able to apply enough force with the algometer to reach the subjects' tolerance, thus those subjects were excluded. Therefore, the results are based on 32 subjects, 15 subjects in the treatment and 17 subjects in the control group.

The threshold and tolerance increases for both the control and treatment between the two measurements. The Improvement in threshold and tolerance is illustrated in Figure III.

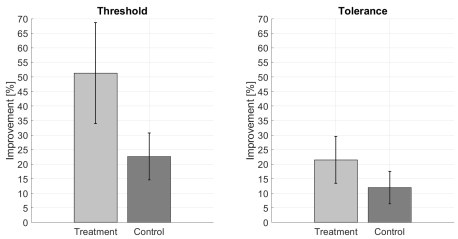

Figure III: *Improvement for threshold (left) and tolerance (right) with associated standard error for treatment group (light grey) and control group (dark grey).*

The Shapiro-Wilk test showed a normal distribution ($\alpha > 0.05$) and the Levene's test showed equal variance ($\alpha > 0.05$) for the threshold and tolerance Pre and Post for both, treatment and control group. Therefore the two-way mixed ANOVA was applied. Hereby the Pre and Post measurements of threshold and tolerance were compared to assess the within-subjects effect. The groups, treatment and control, were compared to assess the between-subjects effect. The results from the two-way mixed ANOVA are illustrated in Table I for threshold and in Table II for the tolerance.
The test indicates that there is a significant main effect between Pre and Post of the threshold measurements (within-subject effect, Measurement), $F(1,30) = 13.051$, $p = 0.001$. However, no significant main effect is seen between

Table I: *Two-way mixed ANOVA for the threshold Pre and Post for treatment and control group respectively. P-values marked with an asterisk indicate significant difference. F-value and degree of freedom (df) are illustrated as well.*

Within-Subjects Effect			
	df	**F**	**Sig**
Measurement	1	13.052	0.001*
Measurement x Group	1	0.451	0.507
Between-Subjects Effect			
	df	**F**	**Sig**
Group	30	1.492	0.231

the treatment and control group for threshold (between-subjects effect, Group), F(1,30) = 1.492, p = 0.231 nor a significant main interaction between measurements and group (within-subjects effect, Measurement x Group), F(1,30) = 0.451, p = 0.507.

Table II: *Two-way mixed ANOVA for the tolerance Pre and Post for treatment and control group respectively. P-values marked with an asterisk indicate significant difference. F-value and degree of freedom (df) are illustrated as well.*

Within-Subjects Effect			
	df	**F**	**Sig**
Measurement	1	8.918	0.006*
Measurement x Group	1	0.532	0.472
Between-Subjects Effect			
	df	**F**	**Sig**
Group	30	3.289	0.080

The test indicates that there is a significant main effect between Pre and Post of the tolerance measurements (within-subject effect, Measurement), F(1,30) = 8.981, p=0.006. However, no significant main effect is seen between the treatment and control group for threshold (between-subjects effect, Group), F(1,30) = 3.289, p = 0.080 nor a significant main interaction between measurements and group (within-subjects effect, Measurement x Group), F(1,30) = 0.532, p = 0.472.

The Shapiro-Wilk test showed a normal distribution ($\alpha > 0.05$) and an unequal variance (p = 0.013) for the Improvement in threshold and tolerance for both groups. Therefore the T-test was applied. The results from the T-test are illustrated in Table III.

Table III: *T-test for threshold and tolerance Improvement (Imp) for treatment and control group. P-values marked with an asterisk indicate significant difference.*

Threshold	**Tolerance**
0.149	0.330

The test indicates that there is no significant difference in Improvement in the threshold and tolerance between both groups.

IV. Discussion

i. Summary and interpretation of the findings

There was seen an overall increase in the threshold and tolerance within the two measurements for both, the treatment and control group. However, no significant difference in pressure pain threshold and pressure pain tolerance between the groups was found. Through a significant difference was found between the measurements, Pre and Post, indicated by the two-way mixed ANOVA. Furthermore, no significant difference in Improvement in threshold and tolerance was found between the groups, indicated by the t-test. Nevertheless a tendency can be seen that the treatment group has a higher Improvement increase in both, threshold and tolerance, compared with the control group. These results indicate that there might be habituation effect on pressure pain.

ii. Experimental Setup

One of the drawbacks of the manual algometer is the difficulty in assessing objectively the rate

in pressure application. Accordingly different studies insist in the importance of training and practice with the algometer. However, due to the available time to execute the project, an appropriate training period was not possible, which would be convenient in order to achieve more reliable values.

Pain tolerance is less used for research purposes due to ethical reasons as well as its high variability among the subjects [**?**]. It appears convenient to only focus on the pressure pain threshold instead of the pressure pain tolerance. This is not only for the extensive variety in the results, but also the validity of the measurements as it was for some subjects not possible to reach a representative pressure pain tolerance.

A study by Tesarz et al. [9] concludes that pain perception can be altered by physical activity. Subjects with good physical condition participating in the study, showed higher threshold and tolerance values compared with other subjects. The muscle of these subjects is also more appropriate to apply the pressure on. Furthermore a study by Koltyn et al. [10] determines that high-intensity exercise is followed by hypoalgesia. Therefore pain threshold and tolerance values increase during and after exercise. The exclusion criteria should take into account that subjects cannot practice physical exercise involving the upper part of the thorax before the measurements.

iii. Meditation technique

There were some limitations within the used meditation technique. Potentially the used audio-guide did not ensure that the subjects understood the principles of mindfulness FA meditation, even though an orally introduction was given on the first day. However, this introduction was provided by a non-specialist, who possibly did not know the key focus of explaining mindfulness meditation to laymen. This uncertainty was based on board spectrum of mindfulness meditation techniques and their unclear delineations. Furthermore, the subjects were told to meditate in the most comfortable position, which varied between the subjects. Inconsistent sitting positions may have influenced the meditation outcome of single subjects. In addition, there was no control, if the subjects were meditating in the adequate.

Other studies have shown that mindfulness meditation has an effect on pain. Those studies investigated the effect of a meditation practice over two months or more using MBSR. [11, 12] The effect on pain intensity and pain unpleasantness of short-term mindfulness meditation practice was shown by Zeidan et al. [8]. However, Zeidan et al. [8] used a meditation technique which was a combination of FA and OM, particularly focusing on pain-related brain processing. Whereas this study was investigating the effect of regular short-term mindfulness FA meditation. Hence pain relief is affected not only by the type of meditation but also by the practice period depending on the meditation technique. Therefore 5 consecutive days may not sufficient to elicit mindfulness FA meditation's modulation of pain.

V. Conclusion

Short-term mindfulness FA meditation on 5 consecutive days did not show a significant effect on pressure pain relief on the upper trapezius in this study. A significant effect was however found between Pre and Post measurement for both control and treatment, which was seen as an increase in pressure pain Wherefore a clear conclusion on the effect of mindfulness FA meditation on pain relief cannot be stated. Nevertheless this study still contributes to the field of pain relief using mindfulness meditation as an alternative method. Since this study shows the tendency that mindfulness FA meditation increases both, threshold and tolerance, a longer period of practicing mindfulness FA meditation should be investigated. Furthermore, this study indicates that the effects of mindfulness meditation varies depending on the meditation technique. Hence the effects of the different meditation techniques should be further investigated in order to evaluate if different meditation techniques have various

effects on pain relief.

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