

1 **Meditation music improved the quality of suturing in experimental bypass procedure**

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29 **ABSTRACT**

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31 **BACKGROUND:** Neurosurgeons are vulnerable to additional noise in their natural operating
32 environment. Noise exposure is associated with reduced cognitive function, inability to concentrate,
33 and nervousness. Meditation music provides opportunity to create a calmer environments which
34 May reduce stress during surgery.

35 **METHODS:** A pilot study was performed to find suitable task, meditation music of surgeon's
36 choice, operation noise and to reach a certain level of training. For the main experiment, two
37 neurosurgeons with different microsurgical experience used real operation noise and meditation
38 music with delta waves as mediating music. Each surgeon performed 10 training bypasses (5 with
39 noise and 5 with music) with 16 stitches in each bypass. The total time to complete 16 stitches,
40 number of unachieved movements (N.U.Ms), length of thread consumed and distribution of the
41 stitches were quantified from the recorded videos and compared in both groups.

42 **RESULTS:** The N.U.Ms were significantly reduced from 109 ± 38 with operation room (OR)-
43 noise to 38 ± 13 ($p < 0.05$) with meditating music in novice surgeon. Similar results were found if the
44 experienced surgeon performed the same task [(from 29 ± 6.94 to 14 ± 3.36 ($p < 0.05$)]. The total
45 time utilized for the sixteen stitches was slightly improved (not significantly) in novice surgeon and
46 unchanged in experienced surgeon. However, the thread length used for 16 stitches was
47 significantly different with OR-noise in comparison to meditating music in both surgeons. The
48 distribution stitches showed a non-significant trend towards a uniform distribution with meditation
49 music in both surgeons.

50 **CONCLUSIONS:** Meditation music of surgeon's choice is a simple method that improved quality
51 of bypass suturing in experimental bypass procedure.

52 **Key words:** Operation Room, Noise, Meditation, Music, Neurovascular, Bypass

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55 **Introduction**

56 Neurosurgery includes many highly skill-demanding and stressful procedures, such as bypass
57 surgery. The "stress rate" and drivers of stress are different for each neurosurgical procedure and for
58 each neurosurgeon. Stitching during bypass surgery is one of the procedures, which holds high level

59 of stress. It necessitates a focused attention to achieve good quality in optimal time. The goal of high
60 quality stitching in a short period of time can lead to stress and anxiety[11].

61 Environment, including the noise, in the operation room is an important factor specially in distracting
62 surgeon's concentration and increasing the stress [14]. Stress is known to influence the heart beat
63 variability and other vegetative function [33]. Hence, the strategies to reduce distraction, anxiety, and
64 release the stress of the surgeon may be helpful to improve the quality of surgery

65 Meditating music may help to circumvent debilitating effect of stress on the fine motor skills of the
66 neurosurgeon. Meditation and meditating music has been shown to relieve stress, and improve
67 learning [1, 26]. There is increasing evidence that music attenuates symptoms in a variety of diseases
68 including Parkinson's disease, dementia and attention deficit syndrome [23]. Intense pleasure in
69 response to music activates the dopaminergic system in striatum and mesolimbic system. Dopamine
70 release in the central nervous system has implication in combating stress [28, 29]. The dopaminergic
71 and serotonergic deep nuclei are linked to the motor cortex supporting the possibility that fine motor
72 skills might be influenced by the meditating music. Evidence from literature supports the notion that
73 sound, the auditory system and the motor system are interconnected and hence may control the fine
74 motor movements [10, 37].

75 We aim to investigate the influence of meditating music and compared it with the influence of
76 operation room noise on surgical performance. We introduced meditating music on our already
77 established experimental bypass surgery to investigate the difference in quality of suturing during
78 OR-noise and meditation music of surgeon's choice.

79

80 **Materials and methods**

81 We recorded the videos of stitching artificial vessels and investigated different parameters to quantify
82 the quality of bypass suturing. These parameters included unachieved movements of surgeon,
83 distribution of the stitches, time utilized and total length of thread used for sixteen microsurgical
84 stitches. These parameters were evaluated in an environment with routine operation room noise in
85 comparison to meditating music. We investigated the above-mentioned parameters in two surgeons
86 with different training experience. The experiment was conducted at the Neurosurgical Department
87 in the Helsinki University Hospital, using an OPMI PENTERO 900 ZEISS inside an OR (Fig.1A)

88 In this experimental study, all training tasks simulating bypass suturing were end-to-side procedures.
89 The tasks were performed by first author (S.M), a fully training EU board certified neurosurgeon

90 (2017) worked as a clinical fellow in neurovascular and skull base microneurosurgery for one year
91 (2018), and the last author (A.H), who finished his residency 20 years ago and who has performed
92 1,500 different experimental bypass procedures over past 4 years, between June 2014 and July 2017,
93 in the Department of Neurosurgery, Helsinki University Hospital, Helsinki, Finland.

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97 **Experiment Design**

98 A vessel wall suturing procedure was simulated. The two participants were asked to suture an already
99 cut in scaphoid-shaped silicon tube. They were required to distribute 16 stitches with four knots.

100 We designed our model by developing a shape similar to the shape of bypass suturing end-side
101 interrupted stitching. The shape was developed, using a millimeter paper (Fig. 1B). We chose the
102 4mm diameter tube and 16 stitches to be used with 4 corner stations, which allow measuring the
103 distances between stitches, which perfectly supposed to be one millimeter (Fig. 1C).

104 The participants were asked to suture in the same order; the numbers (1 to 4) in the model were
105 used to keep participants direction and order of suturing (Fig. 1B). The magnification during
106 suturing was (8 times) in all 20 cases.

107 We used same 9-0 suturing material (PROLENE, 13 cm, 5.0 mm, 3/8c, ETHICON) and same
108 micro-instruments (i.e. scissors, needle holder and forceps) in all procedures (Fig 1A).

109 All videos were analyzed blindly after finishing all the cases. Suturing time was measured from
110 video. The length of thread consumed by the procedures was measured by measuring the length of
111 remaining thread. The repeated movements, which did not achieve the intention goal (e.g. catching
112 the needle, catching the tube wall with tweezers) were counted carefully from videos. The
113 distribution of stitches was quantified by giving a score based on the uniformity of distribution
114 (distance between each stitch) of 16 stitches on the vessel wall (Figure 1C).

115

116 **Statistical analysis:**

117 The data were analyzed using GraphPad Prism 5.00 (GraphPad Software, San Diego, CA, USA).
118 After testing for normality, unpaired t test and welch, s correction was performed in case of non-
119 normal distribution to compare two groups.

120 Data is expressed as mean \pm SEM, a p value < 0.05 was considered as significant difference.

121

122 **Results:**

123 Results of video analysis of the procedures for novice surgeon and experienced surgeon using original
124 operation noise and meditating music are summarized in table 1. Interesting, the N.U.Ms were
125 significantly reduced from 109. \pm 38 with OR-noise to 38 \pm 13 (p< 0.05) with meditating music in
126 novice surgeon (Fig. 2 B). Similar results were found if the experienced surgeon performed the same
127 task. The N.U.Ms was reduced from 29 \pm 7 to 14 \pm 3 (p<0.05) showing that meditation influenced
128 positively the surgeons motor skills independent of experience and training (Fig.2 A &B). Stitch
129 distribution did not differ significantly (Fig 5 A & B).

130 Moreover, the length of thread used for the sixteen stitched was significantly reduced from 8 \pm 1 cm
131 with OR-noise to 5 \pm 0.46 (p< 0.05) with meditating music in novice surgeon (Fig. 4B). Similar results
132 with significantly less use of thread for 16 stitches was quantified in experienced surgeon (Fig. 4A).
133 showing a reduced length of thread needed for 16 stitched from 9 \pm 0.42 cm to 7 \pm 0.45 cm (p<0.05)
134 (Fig. 4 A & B). The total time utilized for the sixteen stitches was slightly improved (not significantly)
135 in novice surgeon (Fig. 3B) and unchanged in experienced surgeon (Fig. 3A). Interestingly, the
136 N.U.Ms fluctuated during the OR-noise and they were less fluctuating with meditating music over
137 the time of five repeated experiments (table 1).

138

139 **Discussion**

140 This study assessed the influence of meditating music on the performance of the neurosurgeons,
141 recruiting the highly demanding procedure: the bypass.

142 Meditation may reduce the stress and influence the motor skills of surgeons. However, music and
143 task is a complex field and may depend on personality of surgeon, choice of music, and other many
144 other factors. Up to our knowledge this is the first study showing improvement of the quality of
145 stitching with music in an experimental setting.

146 Previous studies showed the intervention of external distraction on the neurosurgical performance
147 [13, 14]. Noise is a known health hazard leading to stress, and decrease the concentration [15, 30].
148 Relaxing atmosphere of the operation room might be a factor, which helps surgeon to achieve better
149 performance.

150 The meditation has been shown in various studies to influence different brain areas [5, 9, 33, 35]. It
151 has been used to reduce the stress, anxiety and depression in patients and in healthy individuals [21,
152 31]. Music is known to have influence on the mood and physiological responses [2, 29]. It has been
153 used as an independent nursing intervention for preoperatively in patients having day surgery [7].

154 The trainees experience a different levels of stress and anxiety before and during surgical procedures
155 [3, 12, 22]. Neurosurgical operations hold high level of anxiety, demands certain level of hand-eye
156 coordination, and fine manipulation [4, 6, 8, 17, 36].

157 The senior and expert neurosurgeons compete better with complex surgeries and stressful situation
158 than novice ones [5, 16]. In contrast, at the time of new resident the operation room noise and
159 movement levels are changed dramatically. Opposite to the norm and trend, in which the seniors get
160 more calm atmosphere, the novice and less experience neurosurgeons in need of more comfortable
161 and less noisy operation room[14].

162 Meditation and meditating music is becoming increasingly popular and achieving scientific support
163 [20]. It could help in stressful circumstances and overcoming part of the anxiety associated with
164 surgical procedures. Our study showed that meditating music improved the quality of bypass
165 independent of training level. Fortunately, not all neurosurgical procedures hold such high level of
166 challenge with associated anxiety and stress. Hence, the result could be less dominant in simple
167 routine and daily procedures.

168 The comfort and relaxed hearing voice (meditating music) may improve efficiency and decrease the
169 operative time. Our results showed improved efficiency measured by number of unachieved
170 movements during surgery (Fig.2 A & B). However, our result showed only a trend toward improved
171 time (Fig 3 A & B). The comfortable voice and experience of the surgeon are directly related, and the
172 lack of experience would translate directly to slower, more hesitating movement, and less flexibility.
173 In our experimental task the less experience neurosurgeons saved more length of the thread but
174 consumed extra time and repeated more unachieved movements (Table 1).

175 Meditating music is well established as a way of adjusting the animal and human behaviors [19, 32,
176 34]. However, different meditation forms could affect different cognitive processes [20]. Using

177 meditating music could calm body movements and optimizes movements, which help in achieving
178 better motor performance [24].

179 Music acts as non-pharmacological intervention that attenuates a variety of symptoms in various
180 diseases, such as Parkinson's disease, atrial hypertension, dementia, and attention- deficit/
181 hyperactivity disorder [23]. It changes the concentrations of dopamine, serotonin in deep brain nuclei
182 linked to the motor area [37]. The relationship among sound, auditory circuitry, and motor systems
183 which control the fine movements is well established in the literature [37]. The hearing stimuli has a
184 remarkable ability to drive rhythmic, metrically organized motor behavior [25, 27].

185 There are inevitable background noise in operation room as well as distractions [18]. Our older study
186 proved the difficulty of engaging in a secondary task during surgery and the negative impact of the
187 voice distraction [14]. The experienced neurosurgeons could compensate the stress of operation
188 atmosphere including the noise. However, the type and the level of distraction in one hand, and the
189 level of the complexity of the procedure in other hand cannot be ignored. When the procedure is high
190 -skill demanding, such as bypass neurosurgery, the external stimulation becomes crucial.

191 Our data with some limitations show that performance was worse during practicing bypass under the
192 influence of operation room noise compared to the meditating music. The effect was different
193 between the two subjects (neurosurgeons), based on the past experience with the procedure. Even
194 with extra attention paid by neurosurgeons to complete the task, trying ignoring the sound of the
195 operation room, still the irritating sound reflected the performance as well as laid its effect on the
196 results. The price of the noise and the benefit from the meditating music reflected on the number of
197 unnecessary movements before achieving the intentional goal (Fig2 A & B). For example; penetrating
198 the wall of the tube, tight the stitch, holding the needle, and others.

199 Finally, even with small number of procedures, learning curve and adaptation with the noisy operating
200 sounds were noticed in our trial. The individual endurance level of tension and ability to cope with
201 noise distraction stands behind differences in handling such matter in our field.

202

203 **Limitations**

204 The main limitation is that this study includes a limited number of surgeons; only two surgeons
205 involved, and no randomization of the exercises. Therefore, the results might partially reflects their
206 personal traits and the different volume of bypass training they underwent previously. Moreover,
207 repeating the task and learning effect (learning curve theory) could influence the result.

208 Although it is attractive study with important findings, it is less realistic than naturalistic observation.
209 Although suturing style and designed task are recruited from bypass procedure, this task does not
210 simulate all the bypass steps. This study covers a narrow corner in everyday neurosurgical practice.
211 However, it is part of a series of studies focusing on the training quality in neurosurgery.

212

213 **Conclusions**

214 We conclude that the noise influenced performance of the surgeon, especially when performing
215 complex task such as bypass procedure. The meditating music could positively impact the
216 automaticity of surgical performance. Level of noise and experience of the neurosurgeons can affect
217 the outcome of the surgery. To achieve better outcome, the noise level inside the operation room and
218 use of individual meditating music may be considered

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220

221 **Table 1.** Video analysis of different factors to quantify the quality of bypass procedure for (Novice
222 surgeon), (experienced surgeon), using recording of real operation noise and meditating music

223

224 **Figure legends**

225 **Figure 1A.** Experimental setup and the surgeon and microscope inside the OR. Video recording of
226 bypass suturing, designed task, and silicon tube and suturing instruments are seen on the screen.

227 **Figure 1B.** Schematic view of the suturing task. The diamond-shaped “rhombus” with 4 mm length
228 of its four sides (red arrow). The tube diameter also is 4 mm. The axis located in this direction. The
229 numbers (1, 2, 3, and 4) was sutured first in order and then starting from number 1 clockwise (black
230 curved arrow) to complete the 16 stitches at the end. The background of the design is a millimeter
231 paper was used after suturing to analysis the result.

232 **Figure 1C.** Suturing sample captured from a recorded video, after completion of experiment we used
233 the millimeter paper to examine the distribution of the stitches.

234 **Figure 2.** Number of unachieved movements with operation noise and after meditating music in both;
235 experienced surgeon (A), n=5, unpaired t-test (p=0.0027) and novice surgeon (B), n=5, unpaired t-
236 test (p=0.017)

237 **Figure 3.** Time of suturing with operation noise and after meditating music in experienced surgeon
238 (A), n=5, unpaired t-test (p=0.52) and novice surgeon (B), n=5, unpaired t-test (p=0.27)

239 **Figure 4.** Length of thread used with operation noise and after meditating music in experienced
240 surgeon (A), n=5, unpaired t-test (p=0.0001) and novice surgeon (B), n=5, unpaired t-test (p=0.017)

241 **Figure 5.** Distribution of stitches with operation noise and after meditating music in experienced
242 surgeon (A), n=5, unpaired t-test (p=0.073) and novice surgeon (B), n=5, unpaired t-test (p=0.57)

243

244 **Conflict of interest:** All authors certify that they have no affiliations with or involvement in any organization or entity
245 with any financial interest, or non-financial interest in the subject matter or materials discussed in this manuscript.

246 **Compliance with the ethical standard**

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Refereces

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