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Original article

Effect of Mozart music on heel prick pain in preterm infants: a pilot randomized controlled trial

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Abstract

Objective: The aim of this pilot study was to determine the effect of music by Mozart on heel prick procedural pain in premature infants.

Background: Painful procedures are routinely performed in the setting of neonatal intensive care unit (NICU). Pain may exert short- and long-term deleterious effects on premature babies. Many non-pharmacological interventions have been proven efficacious for blunting neonatal pain.

Study design: Randomized, controlled trial.

Methods: The study was carried out in the NICU of the "G. Rummo" Hospital in Benevento, Italy. The sample consisted of 42 preterm infants, with no hearing loss or significant cerebral lesions on cranial ultrasound. They were randomized to receive heel lance during a music condition or a no-music control condition. We set strict criteria for selecting and delivering the music. Baseline and postprocedural heart rate and transcutaneous oxygen saturation were manually recorded. The Premature Infant Pain Profile (PIPP) score was used to measure the behavioral response to prick. An unpaired t-test was performed for the intergroup comparisons.

Results: There were significant differences between groups on heart rate increase, oxygen saturation reduction and PIPP score following the procedure.

Conclusions: Listening to Mozart music during heel prick is a simple and inexpensive tool for pain alleviating in preterm stable neonates.

Keywords

Mozart music, premature infants, heel prick, pain, randomized controlled trial.

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Introduction

It is firmly demonstrated that neonate babies do experience pain when undergoing painful procedures and stressful stimuli [1]. Neurophysiological pathways for pain perceiving and relief are well represented in the fetus with the preterm infants showing a lower threshold to noxiuos stimuli than the full-term neonates. This is partly explained by the lack of the inhibitory control in the immature spinal cord [2, 3]. Still, preterm neonates show abnormal responses after repeated stimulation leading to a hypergelsia and to established or chronic pain [4]. Pain exposure in the setting of neonatal intensive care unit (NICU) may have short- and long-term detrimental effects. As a matter of fact, the painful stimuli have been implicated in the causation and/or extension of intraventricular hemorrhage (IVH) and periventricular leukomalacia (PVL) [4]. In addition, NICU pain experience may affect development of pain system as well as contribute to long-term neurodevelopment disabilities (i.e. attention, learning and behavioral problems) in such vulnerable infants [5].

Therefore, the management of pain in the premature infants represents a critical issue in the NICU, where discomfortable but unavoidable procedures are performed.

Background

Heel prick is a painful procedure routinely used in the NICU to obtain blood from infants [6]. The administration of sucrose and the use of skin-to-skin contacts have been most frequently studied among the non-pharmacological interventions to manage heel lance related pain in preterm infants [7].

To our knowledge two studies evaluated efficacy of music during heel prick. Bo and Callaghan compared the effect of nonnutritive sucking (NNS), music therapy combined with intrauterine maternal pulse sounds (MT), NNS plus MT and no intervention on heart rate, transcutaneous oxygen levels and pain behavior on 27 neonates undergoing heel stick procedure in the NICUs. The authors found that NNS plus MT had the strongest effect on neonates' oxygen saturation levels and pain response whereas MT alone had the strongest effect on neonates' heart rate [8]. Butt and Kisilevsky evaluated the physiological and behavioral outcomes during recovery from heel lance performed under music condition (both vocal and instrumental lullaby by J. Brahms) and no music condition in 14 preterm infants using a cross-over design. Infants older than 31 weeks of post-conceptional age showed significant benefits from music on heart rate, behavioral state and pain [9]. Music is weakly recommended as non-pharmacological strategy on pain reactivity in newborns due to the several drawbacks of the studies available so far [10, 11].

We conducted a pilot, randomized clinical trial to assess the effect of Mozart music on physiological (heart rate and oxygen saturation) and behavioral responses (Premature Infant Pain Profile [PIPP] scale) [12] to pain after a heel stick in premature neonates. For this purpose we tested premature infants randomly assigned to receive heel lance procedure during music condition or no-music control condition.

Methods and materials

Preterm infants with a postmenstrual age at birth between 27 and 36 weeks were recruited in the NICU at the "G. Rummo" Hospital of Benevento from September 2011 to March 2012 and assessed for study outcomes at a chronological age comprised between 7 and 14 days. We checked at discharge that all infants who had been enrolled in the study had the Transient Evoked Oto-Acustic Emissions (TEOAE) test passed and PVL ruled out. Exclusion criteria were need for analgesia and sedation, invasive or non invasive respiratory support, diagnosis of severe IVH or active sepsis.

Music elements and sound equipment

A thorough examination of music features was priorly made in order to identify a song providing stability, consistency and predictability. The piece choosen was the "*Adagio*" from the *Violin Concerto n° 3 in G major, KV 216*, composed by W.A. Mozart. The piece was presented via a single elongated shape case with two speakers at the opposite sides, placed inside the warmer around the infant's head at 30 cm distance from the ears to optimize perception of sound. The case was cleaned and wrapped by sterile drape before each use. To mimic the presence of music recorder sterile drapes were put inside the incubators of control infants as well. High quality digital audio was used to record and reproduce sound. Music was played at a level to be heard over high noise pollution (i.e. noise of the operation of the incubator and white noise of the recoder) but taking into account the permissible volume as recommended by the

American Academy of Pediatric, namely 65-70 dB [13]. A quiet environment outside the incubator was strictly mantained during the assessment. Music was administered 2 minutes before, during and after the heel prick for an overall period of 5 minutes to the intervention group. Eligible infant pairs were randomized by shuffling sealed envelopes. The infants were cared for in warmer and monitored with Philips Intellivue MP30® neonatal bedside monitor for pulse rate and transcutaneous oxygen saturation during the study. Facilitated tucking was used as standard care for all the tested infants. Heel prick was performed within a 2-minute period by trained neonatal nurses who swiped the heel with alcohol, sticked it using a spring loaded device (Tenderfoot™), collected blood and applied a band aid to the injury site. Increased heart rate, decreased oxygen saturation from baseline and behavioral response of pain as measured by PIPP score were assessed to compare response to heel prick in preterm infants randomly allocated to intervention (listening to music) or to control group (no music condition). Infants in the control group did not receive different non-pharmacological intervention to minimize the discomfort of the procedure, but received facilitated tucking. When a heel prick was required for blood sampling, the same researcher manually collected data as the following: baseline heart rate and oxygen saturation 1 minute before the prick, the maximum heart rate and the minimum oxygen saturation over 1 minute as well as PIPP assessment after the end of the procedure. In order to ensure the blindness of the study, data collector was listening herself to recorded music via headphones. Difference values from baseline records were considered. Statistical analysis was done using SPSS version 19.0 for Windows (SPSS, Inc. Chicago, IL, USA). Data were expressed as mean ± standard deviation (SD). Two tailed, non-paired Student's t-test was performed to compare the two groups. A p-value < 0.05 was set as significant.

Results

We enrolled 42 preterm neonates during the study period. Demographic characteristics are shown in **Tab. 1**. The results are given in **Tab. 2** and plotted in **Fig. 1** (**A**, **B** and **C**). Mean rise in pulse rate from baseline to heel prick was 5.62 (10.10) and 17.1 (12.09) in the intervention group and in the control group, respectively. Heart rate increase was significative lower in the intervention group than in the control group (p = 0.002). Mean decrease in oxygen saturation from baseline after prick was -9.43 (6.81) in the control group; in contrast, infants listening to music displayed a mean increase in oxygen saturation from baseline of 0.76 (2.27), resulting in a significative difference between groups (p = 0.000). The music group also showed a significant lower mean PIPP score compared with the controls (5.14 [1.85] vs 14.38 [4.36]) (p = 0.000).

Table 1. Study population characteristics.

Characteristics	Intervention group	Control group
Gestational age at birth, wk Mean (SD)	30.2 (2.8)	31.8 (3.4)
Birth weight, g Mean (SD)	1,406 (644.3)	1,675.2 (699.3)
Chronological age, d Mean (SD)	12.4 (2.5)	11.3 (2.9)

Table 2. Mean (SD) values for study outcomes.

Oucomes	Intervention group (n = 21)	Control group (n = 21)	p-value
HR (beats/min)	5.62 (10.10)	17.1 (12.09)	0.002
SaO_2 (%)	0.76 (2.27)	-9.43 (6.81)	0.000
PIPP score	5.14 (1.85)	14.38 (4.36)	0.000

HR: heart rate; SpO_2: transcutaneous oxygen saturation; PIPP: Premature Infant Pain Profile.
Differences were considered significant at a p-value < 0.05.

Discussion

Our pilot, randomized, clinical trial showed that exposure to Mozart music significantly lowered the stress response elicited by the heel lance in a population of preterm stable neonates.

We considered pivotal choosing the appropriate music in our setting. Music controls breathing and cardiovascular system through the autonomic nerve. Cardiovascular, including skin vasomotion, and respiratory responses mirror tempo, rhythm, phrase and other characteristics of music [14]. Classical style has been demonstrated to induce a visible relaxation, reduce stress and pain and the need for sedation drugs in adult patients treated in the intensive care setting [15, 16]. This effect is not exclusive to adults. Music therapy is an effective nursing intervention to cope with mild procedural pain in preterm and term neonates and exerts beneficial effects for a wide range of outcomes

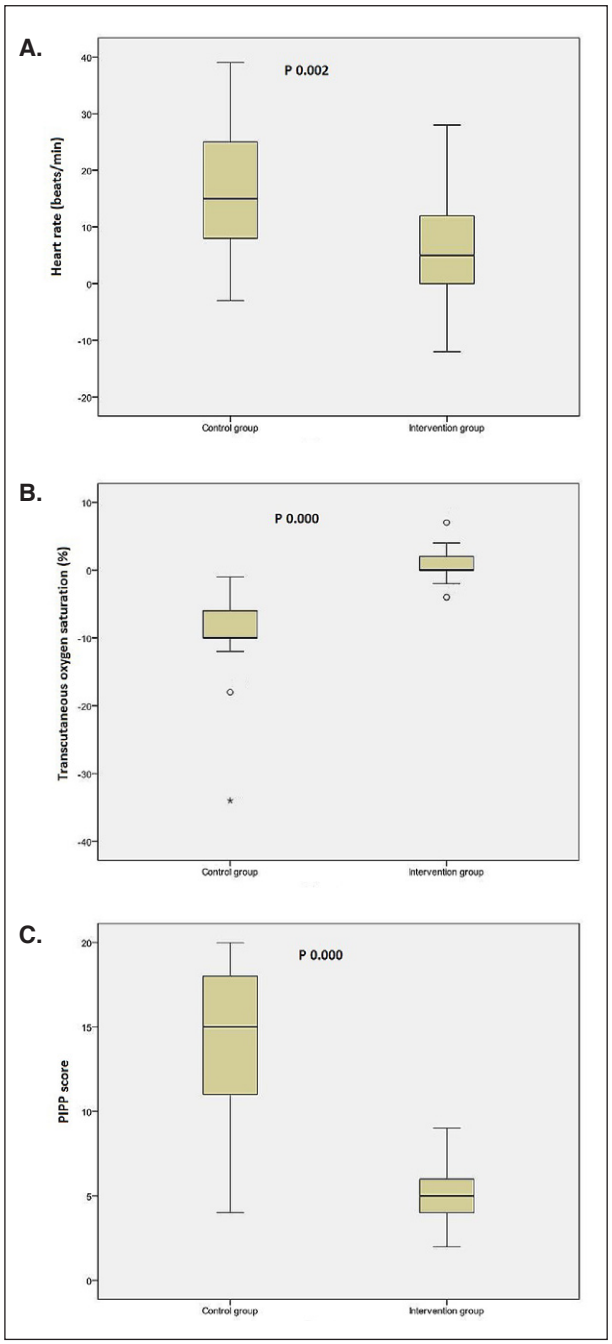

Figure 1. Differences from baseline of heart rate (**A**), transcutaneous oxygen saturation (**B**) and PIPP value (**C**) in intervention and control neonates. The horizontal line inside the box shows the median value. Values outside the inner fences are plotted with circles (°). Values ouside the outer fences are plotted with asterisks (*).

in the NICUs [8, 9, 17-19]. The structures of the auditory system develop early in fetal life, shielded by maternal tissues. The very preterm birth suddenly exposes this neurodeveloping auditory system to the noisy environment of the NICU, putting the basis for hearing, language and cognitive disabilities. It has been speculated that a positive auditory experience is of paramount importance for early brain maturation and healthy neurodevelopment [20].

Therefore, we thoroughly selected the song according to previously defined criteria (i.e. beat, rhythm, melody, armony, texiture and timbre) supposed to diminish stress level. In particular, the major tonality, the consonance inside the tonal organization and the absence of contrapunctually organized musical lines were priorly assumed to be the most relevant in order to promote stability and relaxation. Other set criteria encompassed the slow tempo (i.e. between 50 and 60 beats/min), because it possibly mirrors maternal heartbeat, and instrumental modality of the piece to focus attention on music. In addition, we described a precise mode of music delivery which could provide a comfortable and beneficial cocoon of sound to our premature neonates.

Published trials on music benefits in the NICUs suffer of several methodological flaws [11]. Lack of blinding represents one of the most relevant methodological limitations [21]. We secured the blindness of the data collector in a simple way, as described by Calabro [22], aware of the importance of the bias produced in an open assessment.

We recognize a main limitation of our study. We missed to control for the contextual factors, namely severity of illness and number of previous painful procedures or analgesic medications, as a consequence of the study design. This appraisal has been reported as relevant in the evaluation of the effectiveness of pain relief interventions as being high the variability of pain response across time [23]. Nonetheless, postnatal age on day of testing was very early to possibly prevent the dampening effect of a long stay in the NICU on pain reactivity, particularly in the low gestational age infants [24]. Again, mothers' musical habits should be taken into account because they could influence the assessed outcomes.

In the summary, Mozart music is a valuable and inexpensive strategy to manage pain following heel prick in the premature neonates. Though this study was not designed to address different questions, it is conceivable that the music characteristics and the mode of delivery were of outstanding importance for achieving our goal.

Our pilot data calls for further investigation aimed to compare Mozart music with other non-pharmacological strategies of proven efficacy on reducing stressful stimuli taking into account the recommendations [11] made recently for music therapy research in the NICUs.

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Declaration of interest

The Authors declare that there is no conflict of interest.

Helsinki Declaration statement

The Authors declare that a strict adherence to the ethical principles as set by the Helsinki Declaration was observed during the study.

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