THE EFFECT OF MUSIC ON DISCOMFORT DURING LUMBAR SPINE SPECT SCINTIGRAPHY

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Grant/funding Support: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest: The authors have no conflicts of interest to declare

Highlights

- Music is more of a distraction than an analgesic during SPECT imaging.
- Music makes patients feel less anxious and more relaxed and eases discomfort during lengthy imaging examinations.
- Sedative music has shown to have a positive effect during other imaging modalities.

Abstract

Single photon emission computed tomography (SPECT) imaging forms part of the bone scintigraphy examination in order to significantly improve the detection of skeletal lesions. It has been observed that patients undergoing lumbar spine SPECT scintigraphy frequently complain of general discomfort in the shoulder girdle. Music has been used as an intervention during medical procedures or imaging examinations in an attempt to relieve discomfort and anxiety. The aim of this study was to determine the effect of music, as an intervention, on the perceived discomfort in the shoulder girdle during lumbar spine SPECT scintigraphy. A pre-test post-test quasi-experimental design with two groups was used to conduct this study. Ninety-six consecutive patients routinely referred for lumbar spine SPECT scintigraphy were recruited from two private nuclear medicine practices in Gauteng. Patients were systematically assigned to the control or experimental group. Patients were asked to rate their discomfort at various time points. The results indicate that the group exposed to music as an intervention more frequently reported a decrease in discomfort as compared to the control group. The experimental group also reported less percentage increase in discomfort. There were statistically significant differences in discomfort scores 10 minutes into the SPECT and after the SPECT between the control and intervention groups. Discomfort scores of the control group had a noticeable increase after the SPECT had started. Music as an intervention during SPECT imaging is more of a distraction than an analgesic and can be used to increase patient comfort and the patients' experience.

Keywords: Bone scintigraphy; SPECT scintigraphy; shoulder girdle; discomfort; music therapy.

Introduction

Nuclear medicine is a very sensitive imaging modality that allows one to evaluate the physiological function in the body. Bone scintigraphy is a nuclear medicine examination involving the intravenous administration of a radiopharmaceutical to visualize bone uptake. Areas of increased bone uptake (hot spots visualized on the images) is usually indicative of infection, fractures or malignancy.(Mettler & Guiberteau, 2012; Selberg & Ross, 2012)

Bone scintigraphy can also be used to monitor cancer treatment by comparing follow-up scans to previous scans.(Saha & Saha, 2004) Single photon emission computed tomography (SPECT) imaging forms part of the bone scintigraphy examination in order to significantly improve the detection of small or deep skeletal lesions. SPECT imaging is a technique which provides three-dimensional information of a region of interest. SPECT imaging of the lumbar spine is frequently performed during bone scintigraphy.

From observation in the clinical setting, patients referred for bone scintigraphy experience discomfort in the shoulder girdle during lumbar spine SPECT scintigraphy. The increased discomfort could subsequently lead to patient motion. Motion has severe effects on SPECT image quality and can therefore affect diagnosis.(Saha & Saha, 2004)

Though SPECT imaging is a technological advancement in nuclear medicine, unfortunately the use of impractical and uncomfortable patient positioning is unavoidable. Patients must lie in the supine position with their arms raised above their head for a prolonged period (up to 30 minutes). However, the benefit of the diagnostic value obtained from SPECT imaging requires that these procedures form a crucial part of SPECT scintigraphy despite the potential discomfort experienced by patients.(Izaki, Soares Junior, Giorgi, & Meneghetti, 2014) Discomfort is the perception of slight pain, soreness and numbness that is related to fatigue factors. Discomfort is subjective as every individual has their own perception and sensitivity to discomfort.(Cascioli, Heusch, & McCarthy, 2011)

Attempts have been made to use music as an intervention during medical or imaging procedures since it has been shown to relieve discomfort and anxiety during

procedures such as Positron Emission Tomography (PET). The use of music is reported to have significant effects on vital signs, use of analgesics, decreasing pain intensity and alleviating emotional distress.(Lee, 2016; Lee, Sung, Liu, & Chang, 2017; Ma et al., 2016; Tseng, Chen, & Lee, 2010; Vaajoki, Pietilä, Kankkunen, & Vehviläinen-Julkunen, 2013) Furthermore, music has been shown to alter discomfort perception by distraction. Lee *et al*, (Lee et al., 2017) postulated that music relieves anxiety and increases patient comfort while awaiting procedures that are stressful like PET imaging. Despite the use of music as an intervention in various imaging settings, literature on the use of music during lumbar spine SPECT scintigraphy could not be found.

The aim of this study was to investigate the effect of music, as an intervention, on the perceived discomfort in the shoulder girdle during lumbar spine SPECT scintigraphy.

The focus of the study was to investigate the effect of music on discomfort in the shoulder girdle during lumbar spine SPECT imaging. The effect of anxiety, pain or discomfort on patient motion and image quality was beyond the scope of the current study.

Method

Participants

The study population for this research were patients who were routinely referred to the Nuclear Medicine departments for bone scintigraphy who required lumbar spine SPECT as part of the routine imaging procedure. Patients were recruited from two private Nuclear medicine practices in Gauteng. The setting was selected due to convenience of location, access to the participant population and high frequency of lumbar spine SPECT scintigraphy examinations.
All patients undergoing lumbar spine SPECT scintigraphy, irrespective of the specific indication for the imaging procedure were eligible for the study.

The exclusion criteria were as follows:
Patients that are younger than 18 years of age; patients undergoing bone scintigraphy, without lumbar spine SPECT and patients who were not able to

conform to the required and standard lumbar spine SPECT positioning were excluded from the study. A sample size of 96 consecutive participants that met the inclusion criteria were recruited at the two private nuclear medicine practices. The sample sizes from literature based on the similar research ranged from 62-166 with an average sample size of 99 participants.(Lee et al., 2017; Munn & Jordan, 2014; Tseng et al., 2010; Vaajoki et al., 2013) Participants who agreed, with informed consent, to take part in the study were systematically allocated to the experimental or the control group. Every week, allocation to the two groups would alternate. In the first week, all the participants were placed in the control group while in the second week all the participants were placed in the experimental group. This sequence was followed until the sample size was reached.

Design

A pre-test post-test quasi-experimental design was used to conduct this study. Ninety-six patients routinely referred for bone scintigraphy that would include lumbar spine SPECT were systematically assigned to the control or the experimental group. The experimental group were exposed to music as an intervention during the SPECT imaging while the control group underwent standard SPECT imaging with no intervention.(Donohoe et al., 2003)

Measures

A structured data collection tool in the form of a questionnaire was used to collect data on self-reported discomfort scores and the effect of music in the intervention group. The researchers adapted the questionnaire from the study conducted by Voss, Good, Yates, Baun, Thompson and Hertzog.(Voss et al., 2004) The first section of the questionnaire was used to capture demographic information from the participants. The baseline discomfort level of the participants was measured using the Numerical Rating Scales (NRS) prior to the scintigraphic examination and again prior to the commencement of the lumbar spine SPECT scintigraphy. The NRS for pain and discomfort is regularly used and generally preferred to monitor chronic pain intensity in participants. However, self-reported pain and discomfort are prone to inherent subjectivity and participant bias due to the subjective nature of perceived pain and discomfort. It is difficult to differentiate pain and discomfort. The International Association for the Study of Pain states that pain is an experience

which is associated with tissue damage. Although from what the researchers have observed, patients experience discomfort more often than pain. This is why the researchers have focused only on discomfort for the purpose of the study. The NRS is simple to use as the participant can provide a verbal response which the data collector can then record.(Chien, Bagraith, Khan, Deen, & Strong, 2013) Studies have shown that the NRS is more responsive compared to the Verbal Rating Scale (VRS). The NRS is advantageous in the unidimensional assessment of a participant's pain and discomfort intensity.(Chien et al., 2013; Hjermstad et al., 2011) The researchers chose to use an NRS in the questionnaire to measure the discomfort of the participants. A structured questionnaire which included the NRS was completed for each participant.

In addition, overall experience of discomfort after 10 minutes into the SPECT scintigraphy as well as the overall experience after the procedure of the lumbar spine SPECT scintigraphy was recorded once the SPECT scintigraphy was completed. In the final part of the questionnaire, participants were asked additional questions in both the control group and the experimental group regarding the intervention or lack of intervention during the scintigraphic examination. An open-ended question for the experimental group was asked where participants were requested to state how the music made them feel. The questionnaire provided was color coded for ease of use with control and experimental groups. The questionnaire allowed the researchers to evaluate the discomfort levels prior to the procedure, during the procedure and after the procedure. The additional open-ended question for the experimental group made it possible for the participants to express their opinion of the use of the intervention in a different manner to the NRS. Open ended responses were cross-checked and summarized by two researchers to ensure consistency and credibility in reporting the results. (Brink, Van der Walt, & Van Rensburg, 2012) All of the nuclear medicine practices and departments involved used the same data collection tool. An orientation session, to explain how the data collection tool worked, was held for all of the radiographers that collected the data for the researchers. The data collection tool thus provided accurate and trustworthy results.

The data collection tool underwent a refinement process to test for ease of use, clarity of instructions, omissions, replications and suggestions on improvement, so

that it could be regarded as reliable. The refinement process involved the testing of the questionnaire on two volunteer participants by radiographers affiliated with two practices not involved with the data collection process. Refinement of the tool was performed after ethical approval for the research was obtained. Ethical clearance was granted by the Ethics Committee from the Faculty of Health Sciences, University of Pretoria (Ethical approval number: 74/2018). The questionnaires were refined according to suggestions and recommendations provided by the participants and radiographers involved in the refinement process. Changes implemented after the refinement process regarding the experimental questionnaire included that the volume of the music needed to be increased slightly and the discomfort intensity scale should be displayed to the participant before the scale ratings were recorded. There were no changes suggested for the control group questionnaire during the refinement process.

Procedures

Participants were positioned according to the SNMMI guidelines- supine, feet first into the gantry with their arms extended above the head for the procedure.(Donohoe et al., 2003) Additional arm and knee supporting devices were used during the scintigraphic procedure to assist with accurate positioning and patient comfort where required. Supporting devices were not used for all SPECT studies. The use of supporting devices was determined by patient preference which is the standard practice in the current setting. For the experimental group, the sedative music was played on a CD player as soon as the bone scintigraphic procedure started. The control group underwent imaging with no intervention. Whole-body and static image acquisition preceded SPECT image acquisition according to standard guidelines. (Donohoe et al., 2003) The lumbar spine SPECT image parameters for each patient were kept consistent for each patient. 360° SPECT imaging was completed on a 128x128 image matrix over 64 frames of 25 seconds each on a double-head gamma camera. Therefore, the total time for the lumbar spine SPECT for the patient did not exceed 14 minutes. The questionnaire was used before the commencement of the bone scintigraphic procedure, before the commencement of the lumbar spine SPECT procedure, 10 minutes into the lumbar spine SPECT procedure and at the end of the lumbar spine SPECT procedure.

Questionnaires were collected at the end of every second week by the researchers. Data from the questionnaires were captured on a Microsoft Excel spreadsheet and analyzed using STATA 14 (StataCorp, USA) software. The researchers sorted the data according to the control and experimental group to determine if the music as an intervention had an effect on the participant's discomfort during lumbar spine SPECT scintigraphy. The demographic data which consisted of categorical variables is presented in terms of frequencies and percentages. Continuous data in the form of discomfort rating scales were analyzed by using descriptive statistics such as: the median and inter-quartile range. The t-test was used to test for differences in mean of discomfort ratings between groups. The additional questions asked were presented in terms of frequencies and percentages for the categorical data. All of the open-ended questions were read and common themes were extracted from the data. Responses from the closed-ended questions were read through, common responses counted and grouped into sub-categories. Tests were evaluated at 5% level of significance. The data analysis was performed in consultation with a biostatistician.

Results

Categorical variables are described and presented as frequencies and percentages. Discomfort scores at different time points are presented as medians and inter-quartile ranges. A p-value less than or equal to 0.05 was considered significant. The characteristics of participants that were systematically allocated to the control group or the experimental group are shown in table 1. There were no significant differences between the groups.

There were supporting devices used during some of the imaging procedures which could have had an impact on the discomfort that the patients would have experienced. The use of supporting devices in SPECT imaging is common practice to ensure correct patient positioning and assist in patient comfort. In some instances, patients may request that the standard supporting devices used be removed. The use of the supporting devices is indicated in table 1.

Table 1. Characteristics of groups

Variable	Control group (n = 42)	Experimental group (n = 54)
Gender		
Male	26 (61.9%)	32 (59.3%)
Female	16 (38.1%)	22 (40.7%)
Average age	60.3 years (±10.3)	60.2 years (±12.8)
Had a previous SPECT	8 (19%)	16 (29.6%)
Experience pain daily	17 (40.5%)	16 (29.6%)
Experience discomfort daily	21 (50%)	28 (51.9%)
Use of arm supporting device	27 (64.3%)	42 (77.8%)
Use of knee supporting device	13 (31%)	18 (33.3%)

Discomfort scores

Patients were requested to rate their discomfort using the Numerical Rating Scale (NRS) from a minimum of 1 to a maximum of 10 at various time intervals. The Mann-Whitney Rank Sum test was used to determine statistically significant differences in self-reported discomfort between the control and experimental groups. These are reported as median discomfort scores and inter-quartile range in brackets (Table 2).

Table 2. Discomfort scores at different time intervals

Time interval	Median discomfort scores		
	Control	Experimental	p-value
Baseline	1.5 (0.4)	0.5 (0.3)	.43
Before SPECT	1 (0.4)	0 (0.2)	.34
10 min into SPECT	2.5 (0.5)	1 (0.3)	.04
After SPECT	3 (0.5)	1 (0.3)	.02

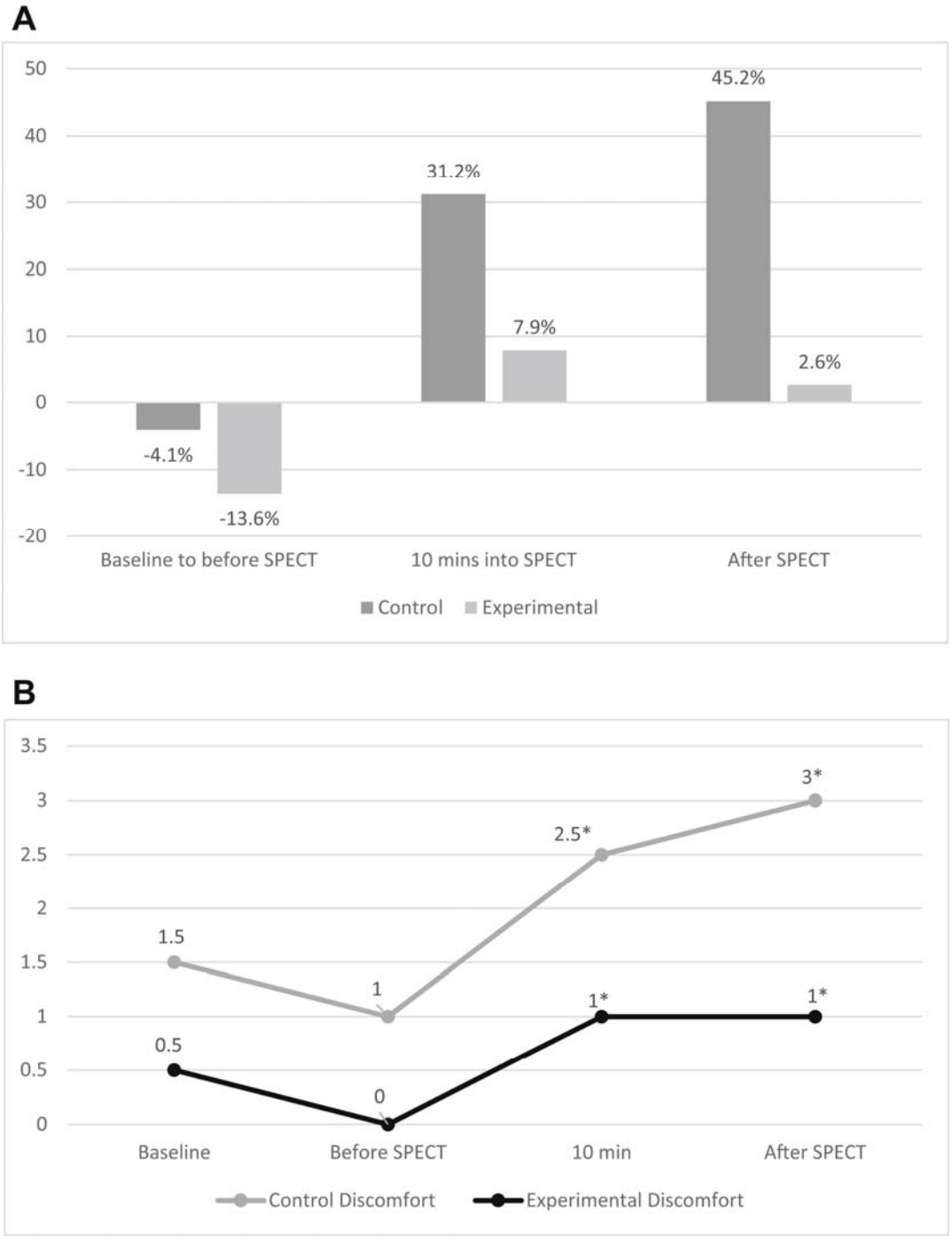

Figure 1. (A) Percentage change in average discomfort scores measured from before SPECT imaging over time. (B) The trend in discomfort scores over the duration of the SPECT.
*p ≤ .05.

The discomfort scores before the procedure and after the SPECT were evaluated to determine the average percentage change in discomfort for the duration of the SPECT (Figure 1A). There was a noticeable percentage increase (31.2% 10 minutes

into the SPECT and 45.2% after the SPECT) in the discomfort reported by the control group. Figure 1B illustrates the trend in discomfort scores over the duration of the SPECT.There were statistically significant differences shown in median discomfort scores 10 minutes into the SPECT and after the SPECT imaging between the control and experimental group (Figure 1B). The baseline discomfort scores were not significantly different.

The line graph shows that there is a decrease in the median discomfort score from the start of the procedure up until before the SPECT for both the control and experimental groups. The control group shows an obvious increase in the discomfort scores from before the SPECT up until after the SPECT. Table 3 indicates the change in discomfort before the SPECT and after the SPECT between the two groups. There were no reported decreases in discomfort in the control group, compared to the nine reports of decreased discomfort in the experimental group (16.7%). Furthermore, there were more reports of increased discomfort in the control group (40.5%) compared to the experimental group (24.1%).

Table 3. Change in discomfort

Group	Discomfort decreased	No change in discomfort	Discomfort increased	p-value
Control n (%)	0 (0%)	25 (59.5%)	17 (40.5%)	.000
Experimental n (%)	9 (16.7%)	32 (59.3%)	13 (24.1%)	.523

A sign test was used to determine whether there were significant changes in the discomfort scores from before the SPECT to after the SPECT within each group (Table 3). The control group had significantly (p=0.000) more increased discomfort scores while the experimental group reported reduced discomfort scores (p=0.523).

Patients in both groups were asked an additional question relating to their perceived discomfort during the procedure. Patients in the control group were asked whether there was something that could have eased their discomfort and whether they

thought music could have influenced their discomfort. Half of the patients in the control group reported that nothing could have been done to decrease their discomfort. Six (14.3%) patients indicated that their discomfort could have been alleviated if their arms were positioned next to their sides. Further responses from the control group included shorter acquisition time (7.1%); different or more supporting devices (7.1%); something to watch to distract them (2.4%). Most patients (69.1%) in the control group felt that music would not have influenced their discomfort compared to the 13 (31%) patients who thought music would have an effect.

It was noted that 40 (74.1%) patients in the experimental group did not comment on the music during the procedure while 14 (25.9%) patients did comment on the music at some stage during the procedure. After the SPECT imaging was complete, patients were asked if they noticed the music playing in the background and how the music made them feel. Only four (7.4%) of the patients did not notice the music playing in the background, whereas the other 50 (92.6%) patients in the experimental group did notice the music. Table 4 summarizes the responses from the patients when they were asked how the music made them feel.

Table 4. Reported feelings resulting from the music

Feelings	Frequency (n = 54)	Percentage
Less anxious and/or relaxed	41	75.9%
Did not hear the music	4	7.4%
Sleepy	3	5.6%
Comforting	2	3.7%
Distracted	2	3.7%
Was not bothered by the music	1	1.9%
Irritated	1	1.9%

Discussion

There were both male and female patients who participated in the study of which the majority of the patients referred for bone scintigraphy studies were oncology related. This can be expected since bone scintigraphy has the ability to detect physiological processes as it is a very sensitive imaging technique. It visualizes osteoblastic activity in the bone, in the healing process after a fracture has occurred or where there are any physiological changes in the bone that cannot be detected by other imaging modalities.(Mettler & Guiberteau, 2012; Van den Wyngaert et al., 2016) Bone scintigraphy for oncology patients is primarily used when the patient has a confirmed cancer diagnosis or where cancer is suspected, to determine whether there is metastatic spread. Whole-body bone scintigraphy plays a significant role in detecting metastatic spread of breast and prostate cancer as these frequently spread to the bone. Furthermore, it aids as an important diagnostic tool to ensure the correct patient management and treatment.(Pyka et al., 2016; Urano et al., 2017)

Discomfort during lumbar spine SPECT scintigraphy

The pre-existing discomfort experienced in the sample of the current study may be regarded as a confounder to the results. However, investigation of the percentage change of discomfort together as well as the number of reported increases or decreases in discomfort yielded significant results.

The discomfort in the shoulder girdle of patients undergoing lumbar spine SPECT scintigraphy was determined at certain time intervals during bone scintigraphy. The trend of discomfort demonstrated that there was an obvious increase for discomfort in the control group compared to the experimental group. All controllable factors were held constant, which implies that the music being tested as an intervention did have a positive effect in the experimental group in reducing the perceived discomfort experienced. The significance lies in the reduced number of patients experiencing an increase in discomfort when music was being used as an intervention. The median discomfort scores from before the start of the procedure until before the start of the SPECT was lower compared to the increase in median discomfort scores from before the SPECT to after the SPECT. This could be due to the fact that the patient positioning for whole-body and static images was more comfortable for the patient compared to their position during SPECT imaging. For whole-body images patients

are positioned supine with their arms strapped to their sides, while during static images the patient is still positioned supine. However, their arm positioning differs depending on which area of the body is being imaged during static imaging. According to the SNMMI guidelines the patient should be positioned with their arms above their head for thoracic and lumbar spine SPECT imaging.(Donohoe et al., 2003) Even though, the patients' arms have to be positioned above their head for some static images, it is still for a shorter period of time as compared to the time for the arm positioning during SPECT imaging. Izaki *et al*, (Izaki et al., 2014) conducted a study on myocardial perfusion imaging patients (where the patient positioning is the same as for lumbar spine SPECT imaging) that concluded with the fact that patients experience pain due to their arm positioned above their heads for an extended period of time.(Donohoe, Brown, & Collier, 2003; Izaki et al., 2014) Some patients reported that if their arms were positioned next to their sides, it would have alleviated their discomfort. However, in SPECT imaging this is not possible. If the arms were to be positioned at the patients' sides, the image quality would be degraded due to tissue attenuation and the images would subsequently be difficult to interpret, leading to a possible impact on patient diagnosis.(Izaki et al., 2014)

Graversen and Sommer (Graversen & Sommer, 2013) conducted a clinical trial to evaluate the impact of music on patients' pain and fatigue post laparoscopic cholecystectomy (LC). Patients were placed in two groups, one with music and the other without music. Their pain and fatigue were monitored prior to surgery, one and three hours post-operatively by using the visual analogue scale. These variables were also followed-up one and seven days after surgery by using a numeric rating scale (NRS). The study found that the post-operative pain did not decrease in the experimental group at one and three hours after the surgery, but only seven days after. However, the patients fatigue decreased one and seven days after surgery. The researchers concluded that, overall in both groups, the pain and fatigue ratings were quite low over time, which may suggest that the music only had a slight effect on the post-operative LC patients.(Graversen & Sommer, 2013) The findings of the current study correlates with the Graversen & Sommer (Graversen & Sommer, 2013) findings which demonstrated that the pain scores decreased slightly over time in the experimental group compared to the control group, but there was no significant difference. Other studies have found music has had a significant effect on the pain

and anxiety over time between control and experimental groups.(Angioli et al., 2014; Nguyen, Nilsson, Hellström, & Bengtson, 2010) Such studies were conducted using children undergoing lumbar punctures and on patients undergoing office hysteroscopy as the target population. These studies showed that the experimental group experienced lower levels of pain compared to the control group.(Angioli et al., 2014; Nguyen et al., 2010) Although these studies were not based on imaging or scintigraphy - the positive effect of music as an intervention for pain and anxiety was confirmed.

The findings of the study conducted by Ma et al,(Ma et al., 2016) correlates with the findings of the current study with regards to music alleviating anxiety and discomfort. Although the current study did not measure stress, the patients reported that the music relaxed them when reporting how the music made them feel. Various studies which correlate with the current results, also found that the music had a positive effect which improved comfort levels, altered pain perception and alleviated anxiety.(Lee, Sung, Liu, & Chang, 2016; Ma et al., 2016; McCaffrey & Locsin, 2002; Tseng et al., 2010; Vaajoki et al., 2013) Therefore, music can be used as an intervention during lumbar spine SPECT scintigraphy to decrease patient discomfort.

The type of music that was played in the experimental group, was sedative music which has been shown to have a calming and soothing effect on patients.(Chi & Young, 2011) This seemed to be true as the majority of patients reported that the music made them feel relaxed and less anxious. Music has been used in studies to relieve anxiety whilst awaiting procedures that are stressful.(Lee et al., 2016, 2017; Ma et al., 2016; McCaffrey & Locsin, 2002; Tseng et al., 2010; Vaajoki et al., 2013) The patients' responses support the findings of these studies with regards to relieving anxiety and increasing patient comfort.

Conclusion

It is known that patients experience discomfort in their shoulder girdle as a result of the uncomfortable patient positioning during a nuclear medicine procedure. Interventions such as supporting devices and sedative music have previously shown to alleviate anxiety as well as general pain and discomfort. Music as an intervention

has not previously been studied during lumbar spine SPECT imaging. Sedative music has shown to have a positive effect during other imaging modalities and post-operative patient management. Therefore, it was deemed important and appropriate to measure the discomfort levels that patients experienced during lumbar spine SPECT imaging with music as an intervention. The median discomfort scores of the experimental group were significantly lower than that of the control group 10 minutes into the SPECT and after the SPECT. In the control group the discomfort scores showed a noticeable increase after the commencement of the SPECT. Even though the experimental group also reported an increase in discomfort, it did not increase as much as compared to the control group. The control and experimental group presented a similar trend for discomfort throughout the analysis however, the control group (not exposed to music as an intervention) more frequently reported an increase in discomfort. Regardless of the small sample size, the experimental group reported a decrease in discomfort more frequently compared to the control group. In addition, the group exposed to music reported a smaller percentage increase in discomfort. These results concur with similar studies in the literature where it was found that music decreases discomfort, alleviates anxiety and alters pain perception to a certain degree. Music was found to be more of a distraction than an analgesic. The researchers recommend that the patients should be given a choice of music – which is still of sedative quality – but which is culturally appropriate and which may help them respond to the music. The researchers also recommend that if a similar study is conducted, the patients who have had previous lumbar spine SPECT imaging should be excluded from the study as their past experiences and knowing what to expect may alter their responses. The researchers suggest that music should be used as an intervention to improve patient comfort and patient experience. Further studies should be performed to determine whether the music selection could have an effect on the patients experience during radioisotope examinations with uncomfortable patient positioning.

Acknowledgments

The authors would like to express our deepest gratitude to our supervisor, Mrs. PL Bresser for her constant support and advisement throughout this research study. Her guidance, patience and immense knowledge has helped us construct and complete this research article. The authors would also like to extend their gratitude to the nuclear medicine physicians and radiographers at Kritzinger, Van Niekerk and Ramjee Inc and NuclearMed for allowing access to their practices to conduct the research. Lastly, we would like to thank the University of Pretoria for giving us the opportunity to further our studies and increase our knowledge in the field of radiography.

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