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**REVIEW**

- 319 Recent advances in endoscopic management of gastric neoplasms  
*Cheema HI, Tharian B, Inamdar S, Garcia-Saenz-de-Sicilia M, Cengiz C*
- 338 Unlocking quality in endoscopic mucosal resection  
*Keating E, Leyden J, O'Connor DB, Lahiff C*

**MINIREVIEWS**

- 354 Improving polyp detection at colonoscopy: Non-technological techniques  
*Rajivan R, Thayalasekaran S*
- 368 Rectal neuroendocrine tumours and the role of emerging endoscopic techniques  
*Keating E, Bennett G, Murray MA, Ryan S, Aird J, O'Connor DB, O'Toole D, Lahiff C*

**ORIGINAL ARTICLE****Case Control Study**

- 376 Effect of modified ShengYangYiwei decoction on painless gastroscopy and gastrointestinal and immune function in gastric cancer patients  
*Mi SC, Wu LY, Xu ZJ, Zheng LY, Luo JW*

**Retrospective Cohort Study**

- 386 Expanding endoscopic boundaries: Endoscopic resection of large appendiceal orifice polyps with endoscopic mucosal resection and endoscopic submucosal dissection  
*Patel AP, Khalaf MA, Riojas-Barrett M, Keihanian T, Othman MO*

**Retrospective Study**

- 397 Effect of music on colonoscopy performance: A propensity score-matched analysis  
*Choi EJ, Jee SR, Lee SH, Yoon JS, Yu SJ, Lee JH, Lee HB, Yi SW, Kim MP, Chung BC, Lee HS*

**Observational Study**

- 407 Diagnostic role of fractional exhaled nitric oxide in pediatric eosinophilic esophagitis, relationship with gastric and duodenal eosinophils  
*Kaur P, Chevalier R, Friesen C, Ryan J, Sherman A, Page S*

**ABOUT COVER**

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Retrospective Study

## Effect of music on colonoscopy performance: A propensity score-matched analysis

Eun Jeong Choi, Sam Ryong Jee, Sang Heon Lee, Jun Sik Yoon, Seung Jung Yu, Jong Hyun Lee, Han Byul Lee, Sang Wook Yi, Myeong Pyo Kim, Byung Cheol Chung, Hong Sub Lee

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### Abstract

#### BACKGROUND

Music has been used to reduce stress and improve task performance during medical therapy.

#### AIM

To assess the effects of music on colonoscopy performance outcomes.

#### METHODS

We retrospectively reviewed patients who underwent colonoscopy performed by four endoscopists with popular music. Colonoscopy performance outcomes, such as insertion time, adenoma detection rate (ADR), and polyp detection rate (PDR), were compared between the music and non-music groups. To reduce selection bias, propensity score matching was used.

#### RESULTS

After one-to-one propensity score matching, 169 colonoscopies were selected from each group. No significant differences in insertion time (4.97 vs 5.17 min,  $P = 0.795$ ) and ADR (39.1% vs 46.2%,  $P = 0.226$ ) were found between the two groups. Subgroup analysis showed that the insertion time (3.6 vs 3.8 min,  $P = 0.852$ ) and ADR (51.1% vs 44.7%,  $P = 0.488$ ) did not significantly differ between the two groups in experts. However, in trainees, PDR (46.9% vs 66.7%,  $P = 0.016$ ) and ADR (25.9% vs 47.6%,  $P = 0.006$ ) were significantly lower in the music than in the non-

music group.

### CONCLUSION

The current study found that listening to music during colonoscopy did not affect procedure performance. Moreover, it suggested that music may distract trainees from appropriately detecting adenomas and polyps.

**Key Words:** Music; Colonoscopy; Performance; Adenoma; Colonic polyps; Cecal insertion time

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**Core Tip:** Music has shown the positive effect on the surgical team in the operating room, no data has been available regarding the effects of music on endoscopist performance. The study aimed to assess the effects of music on colonoscopy performance outcomes. The patients who underwent colonoscopy while listening to music were retrospectively reviewed for colonoscopy performance outcomes, such as insertion time, adenoma and polyp detection rates. Accordingly, our findings showed that listening to music during colonoscopy had no effect on procedure performance. Moreover, our results suggested that listening to music during colonoscopy may distract trainees from appropriately detecting adenomas and polyps.

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## INTRODUCTION

Music has been used in medical treatment to reduce pain and anxiety[1]. Music, which is commonly played in operating rooms during surgical procedures, has a positive effect on the surgical team[2] considering that not only the patient but also the surgeon may feel tense and stressed. Surgeons' stress can negatively affect their skills[3], which can have adverse consequences for the patients. However, there are few means for relieving the surgeon's tension in a constrained operating room. Given its positive effect on the surgical team through a significant decrease in autonomic reactivity, music has been considered one of the few options for relieving the surgeon's tension[4]. Moreover, music performance increases surgical accuracy and shortens the operative time[5,6].

Colonoscopy has been widely performed for the screening of colorectal cancer[7] and evaluation of lower gastrointestinal diseases. However, this procedure causes anxiety and pain in patients due to abdominal clamping or bloating[8]. To reduce the pain of patients and prevent the movement of patients from interfering with the procedure, endoscopists administer a sedative. However, sedatives may increase the risk of cardiovascular disease in elderly people[9]. Several studies have proven that music has a significant effect on reducing anxiety and pain in patients undergoing colonoscopy and the dosage of sedatives required for colonoscopy[10,11]. However, no data has been available regarding the effects of music on endoscopist performance. Therefore, the current study aimed to assess the effects of music on colonoscopy performance outcomes.

## MATERIALS AND METHODS

### Patients

Subjects who underwent colonoscopy at the Gastroenterology Department of Busan Paik Hospital, Korea between June 2019 and March 2021 were enrolled. Since June 2020, all endoscopy procedures had been performed while listening to music. A total of 402 patients underwent colonoscopy during the said period. The identified patients were then divided into two groups: The non-music group, who underwent endoscopy without listening to music from June 2019 to May 2020, and the music group, who underwent endoscopy while listening to music from June 2020 to March 2021.

Clinical data, including the American Society of Anesthesiologists (ASA) score, colonoscopy indications, and pathological findings, were obtained by reviewing past medical records. The ASA score was evaluated to assess patient risk prior to colonoscopy. Patients underwent colonoscopy for several indications, including abdominal pain, hematochezia, melena, diarrhea, constipation, and screening

purposes in asymptomatic individuals.

### **Endoscopists**

Four endoscopists, consisting of two experts and two trainees, participated in the study. Both experts were board-certified and experienced endoscopists, each of whom had performed more than 5000 colonoscopies, whereas both trainees had < 1 year of experience. Their preferred pop music was played through the blue-tooth speakers in the endoscopic room at a volume of between 50 and 60 dB. A colonoscope (CF-H260AL or CF-HQ290L; Olympus, Tokyo, Japan) was used to perform the colonoscopy from June 2019 to March 2021.

### **Bowel preparation**

Bowel preparation was performed using the bowel cleansing product consisting of 2 L of a solution containing polyethylene glycol. The quality of bowel preparation was scored according to the Boston Bowel Preparation Scale (BBPS) and characterized as adequate (BBPS score  $\geq 6$  and/or all segment scores  $\geq 2$ ) or fair (total score of 3-5).

### **Colonoscopy performance outcomes**

Primary endpoints were cecal insertion time, polyp detection rate (PDR), and adenoma detection rate (ADR). The PDR was defined as the number of colonoscopies in which at least one polyp was detected divided by the total number of colonoscopies performed. The ADR was defined as the number of colonoscopies in which at least one adenoma was detected divided by the total number of colonoscopies.

### **Statistical analysis**

Descriptive data were reported as median and interquartile range. Differences in categorical variables were analyzed using  $\chi^2$  test. Continuous variables were analyzed using Mann-Whitney *U* test. Analyses were performed using R Statistical Software 4.1.0 (The R Foundation for Statistical Computing, Vienna, Austria), *P* values of < 0.05 indicating statistical significance. To reduce selection bias, one-to-one propensity score matching was performed using the R package "MatchIt". One-to-one matching was conducted with age, sex, body mass index (BMI), ASA score, BBPS, surgical history, and indication for colonoscopy as covariates using greedy matching with caliper of 0.2. Univariable and multivariable logistic regression analyses were performed to assess independent prognostic factors. The covariates for matching estimation included age, sex, BMI, ASA score, BBPS, previous abdominal surgery, and indication for colonoscopy. Covariate selection for multivariate analysis was based on a *P* value of < 0.2 in univariable analysis, with a logistic regression model.

### **Ethical statements**

This retrospective study was approved by the Institutional Review Board of Busan Paik Hospital and was conducted in accordance with the ethical guidelines stated in the Declaration of Helsinki (IRB number: 2020-01-192). Requirement for informed consent was waived by the Institutional Review Board given that the researchers only retrospectively accessed a de-identified database for analysis purposes.

## **RESULTS**

### **Patient characteristics**

From June 2019 to March 2021, 402 colonoscopies were performed by four endoscopists. A total of 202 colonoscopies were performed while listening to pop music preferred by the endoscopists, whereas 200 were performed without music. The baseline characteristics of the patients are shown in [Table 1](#). Before the propensity score matching, there were significant differences between surgical history and colonoscopy indications. After one-to-one propensity score matching, 169 colonoscopies were selected for each group. The most common indication for colonoscopy was screening of colon cancer, with both groups having the same amount of patient at 51.5% (*P* = 1.000) after propensity score matching. Cecal intubation rate was 100% in both groups.

### **Outcomes of colonoscopy performance**

The insertion time (4.97 *vs* 5.17 min, *P* = 0.795) and withdrawal time (10.57 *vs* 11.87 min, *P* = 0.142) did not significantly differ between both groups. In addition, no significant differences in ADR (39.1% *vs* 46.2%, *P* = 0.226) were observed between the two groups, although PDR tended to higher in the non-music group than in music group (56.8% *vs* 66.9%, *P* = 0.073) ([Table 2](#)).

### **Subgroup analysis according to colonoscopy proficiency**

Subgroup analysis was performed to evaluate differences according to colonoscopy proficiency ([Table 3](#)). Among experts, the insertion time (3.57 *vs* 3.83 min, *P* = 0.852), withdrawal time (10.30 *vs* 10.90

**Table 1** Baseline characteristics of patients who did and did not listen to music before and after propensity score matching

	Before propensity score matching					After propensity score matching				
	Total (n = 402)	Music (n = 200)	No music (n = 202)	P value	d	Total (n = 338)	Music (n = 169)	No music (n = 169)	P value	d
Age, yr	63.0 (54.0-70.0)	63.0 (54.5-69.0)	64.0 (54.0-70.0)	0.642	0.08	64.0 (55.0-70.0)	63.0 (53.0-69.0)	64.0 (56.0-70.0)	0.353	0.13
Female sex	190 (47.3%)	96 (48.0%)	94 (46.5%)	0.846	0.03	157 (46.4%)	83 (49.1%)	74 (43.8%)	0.383	0.11
BMI, kg/m <sup>2</sup>	23.7 (21.9-26.0)	23.7 (21.9-26.2)	23.7 (21.8-25.9)	0.992	0.00	23.7 (22.0-25.9)	24.0 (22.1-26.2)	23.6 (21.8-25.8)	0.383	0.09
ASA score				0.746	0.01				0.546	0.12
1	171 (42.5%)	86 (43.0%)	85 (42.1%)			152 (45.0%)	79 (46.7%)	73 (43.2%)		
2	204 (50.7%)	100 (50.0%)	104 (51.5%)			167 (49.4%)	83 (49.1%)	84 (49.7%)		
3	26 (6.5%)	14 (7.0%)	12 (5.9%)			18 (5.3%)	7 (4.1%)	11 (6.5%)		
4	1 (0.2%)	0 (0.0%)	1 (0.5%)			1 (0.3%)	0 (0.0%)	1 (0.6%)		
BBPS				0.768	0.04				0.684	0.06
3-5	87 (21.6%)	45 (22.5%)	42 (20.8%)			68 (20.1%)	32 (18.9%)	36 (21.3%)		
6-9	315 (78.4%)	155 (77.5%)	160 (79.2%)			270 (79.9%)	137 (81.1%)	133 (78.7%)		
Surgical history				0.041	0.07				0.060	0.02
None	259 (64.4%)	121 (60.5%)	138 (68.3%)			206 (60.9%)	98 (58.0%)	108 (63.9%)		
Colon	99 (24.6%)	60 (30.0%)	39 (19.3%)			94 (27.8%)	56 (33.1%)	38 (22.5%)		
Other abdominal organ	44 (10.9%)	19 (9.5%)	25 (12.4%)			38 (11.2%)	15 (8.9%)	23 (13.6%)		
Indication for colonoscopy				0.002	0.32				1.000	0.00
Screening	207 (51.5%)	89 (44.5%)	118 (58.4%)			174 (51.5%)	87 (51.5%)	87 (51.5%)		
Post operation surveillance	128 (31.8%)	66 (33.0%)	62 (30.7%)			120 (35.5%)	60 (35.5%)	60 (35.5%)		
Patients with symptoms	67 (16.7%)	45 (22.5%)	22 (10.9%)			44 (13.0%)	22 (13.0%)	22 (13.0%)		

Data are expressed as *n* (%), median (interquartile range). *P* values were calculated using Kruskal-Wallis test and  $\chi^2$  test. *d*: Standardized mean differences of propensity-matched population; BMI: Body mass index; ASA score: American Society of Anesthesiologists score; BBPS: Boston Bowel Preparation Scale.

min, *P* = 0.560), PDR (65.9% vs 67.1%, *P* > 0.999) and ADR (51.1% vs 44.7%, *P* = 0.488) did not significantly differ between the two groups. Among trainees, the cecal insertion time (6.30 vs 6.27 min, *P* = 0.831) and the withdrawal time (10.82 vs 13.68 min, *P* = 0.123) did not significantly differ between music vs non-music groups. However, among trainee, the PDR was significantly lower in the music group than in the non-music group (46.9% vs 66.7%, *P* = 0.016). A significant difference in the ADR was

**Table 2 Outcomes of colonoscopy performance with and without music**

	Total (n = 338)	Music (n = 169)	No music (n = 169)	P value
Polyp detection rate	209 (61.8%)	96 (56.8%)	113 (66.9%)	0.073
Adenoma detection rate	144 (42.6%)	66 (39.1%)	78 (46.2%)	0.226
Insertion time (min)	5.09 (3.32-7.33)	4.97 (3.28-7.03)	5.17 (3.43-7.78)	0.795
Withdrawal time (min)	11.1 (8.48-17.25)	10.57 (8.40-16.35)	11.87 (8.63-17.5)	0.142

Data are expressed as *n* (%), median (interquartile range), *P* values were calculated using Kruskal-Wallis test and  $\chi^2$  test.

**Table 3 Outcomes of colonoscopy performance according to expert and trainee subgroups**

	Polyp detection rate	Adenoma detection rate	Insertion time (min)	Withdrawal time (min)
<b>Expert</b>				
Total (n = 173)	115 (66.5%)	83 (48.0%)	3.75 (2.57-5.68)	10.68 (8.22-15.22)
Music (n = 88)	58 (65.9%)	45 (51.1%)	3.57 (2.59-5.80)	10.30 (7.95-15.27)
No music (n = 85)	57 (67.1%)	38 (44.7%)	3.83 (2.42-5.65)	10.90 (8.48-14.10)
<i>P</i> value	> 0.999	0.488	0.852	0.560
<b>Trainee</b>				
Total (n = 165)	94 (57.0%)	61 (37.0%)	6.30 (4.58-8.82)	12.07 (8.92-19.0)
Music (n = 81)	38 (46.9%)	21 (25.9%)	6.30 (4.50-8.70)	10.82 (8.78-17.43)
No music (n = 84)	56 (66.7%)	40 (47.6%)	6.27 (4.78-9.11)	13.68 (9.31-20.33)
<i>P</i> value	0.016	0.006	0.831	0.123

Data are expressed as *n* (%), median (interquartile range), *P*-values were calculated using Kruskal-Wallis test and  $\chi^2$  test.

also noted, with the rate in the music group being significantly lower than that in the non-music group (25.9% vs 47.6%, *P* = 0.006).

### Prognostic factors for adenoma detection and insertion time

Adenoma detection and fast insertion time (< median insertion time of 310 s) were regressed on potential predictors using logistic regression analysis. Among all patients (*n* = 402), univariable and multivariable analyses found that music was not associated with ADR and fast insertion time (Table 4, Figure 1). Expert endoscopists detected more adenoma, although not statistically significant [odds ratio (OR) = 1.42, *P* = 0.085], while younger age (OR = 1.04, *P* < 0.001), women (OR = 0.55, *P* = 0.004), and surgical history of colon (OR = 0.62, *P* = 0.048) showed a significant association with lower ADR in univariable and multivariable regression analyses. Expert endoscopist (OR = 4.69, *P* < 0.001), higher BMI (OR = 1.07, *P* = 0.023), adequate BBPS (OR = 2.09, *P* = 0.003), and previous surgical history of colon (OR = 1.05, *P* = 0.090) were associated with fast insertion time in univariable analyses, and the results of multivariable analyses were the same except for BBPS.

## DISCUSSION

Music has been known to provide a positive effect on surgical performance[12]. On study showed that surgeons who listened to music had reduced operative time and better surgical quality[5]. As with surgeons, music might influence and consequently improve endoscopist's performance, which can lead to reduced insertion time and increased ADR. In support of this finding, a study by Ardalan *et al*[13] showed that PDR and ADR increased when listening to Star Wars music. However, the current study showed that music did not significantly affect colonoscopy performance. Although endoscopist and patient factors may have played a role in these different results, the type of music may also be a factor. Indeed, one study showed that listening to Mozart music improve task performance during laparoscopic surgery simulations[6]. Furthermore, a study on the effect of different music genres on surgical performance showed better performance when listening to classical music or hip-hop music compared to exposure to mixed radio music or rock[14]. While the endoscopist's preferred Korean pop music,

Table 4 Prognostic factors for colonoscopy performance (n = 402)

	No.	Univariable analysis <sup>1</sup>		Multivariable analysis <sup>1</sup>		Univariable analysis <sup>2</sup>		Multivariable analysis <sup>2</sup>	
		OR (95%CI)	P value	aOR (95%CI)	P value	OR (95%CI)	P value	aOR (95%CI)	P value
<b>Music</b>									
No	202	Reference				Reference			
Yes	200	0.86 (0.58-1.28)	0.470			1.24 (0.84-1.84)	0.273		
<b>Endoscopist</b>									
Trainee	207	Reference		Reference		Reference		Reference	
Expert	195	1.42 (0.95-2.11)	0.085	1.35 (0.89-2.06)	0.163	4.69 (3.10-7.19)	< 0.001	4.48 (2.87-7.11)	< 0.001
<b>Age, yr</b>		1.04 (1.02-1.06)	< 0.001	1.05 (1.03-1.07)	< 0.001	0.99 (0.98-1.01)	0.298		
<b>Sex</b>									
Male	212	Reference		Reference		Reference			
Female	190	0.55 (0.37-0.82)	0.004	0.51 (0.34-0.78)	0.002	0.98 (0.66-1.45)	0.916		
<b>BMI, kg/m<sup>2</sup></b>		1.04 (0.98-1.10)	0.193	1.05 (0.99-1.12)	0.123	1.07 (1.01-1.14)	0.023	1.09 (1.02-1.16)	0.010
<b>BBPS</b>									
Fair	87	Reference				Reference		Reference	
Adequate	315	0.78 (0.48-1.26)	0.303			2.09 (1.29-3.45)	0.003	1.17 (0.67-2.04)	0.583
<b>Surgical history</b>									
None	259	Reference		Reference		Reference		Reference	
Colon	99	0.62 (0.38-0.99)	0.048	0.49 (0.29-0.81)	0.006	1.50 (0.94-2.42)	0.090	1.71 (1.02-2.88)	0.042
Other	44	0.74 (0.38-1.41)	0.369	0.76 (0.37-1.50)	0.427	0.25 (0.11-0.52)	< 0.001	0.35 (0.15-0.77)	0.012
<b>Indication</b>									
Screening	207	Reference				Reference			
Post operation surveillance	128	0.76 (0.48-1.19)	0.232			1.09 (0.70-1.69)	0.708		
Patient with symptoms	67	0.88 (0.50-1.53)	0.653			0.76 (0.43-1.31)	0.323		

<sup>1</sup>Adenoma detection.<sup>2</sup>Fast insertion (< median insertion time of 310 s).

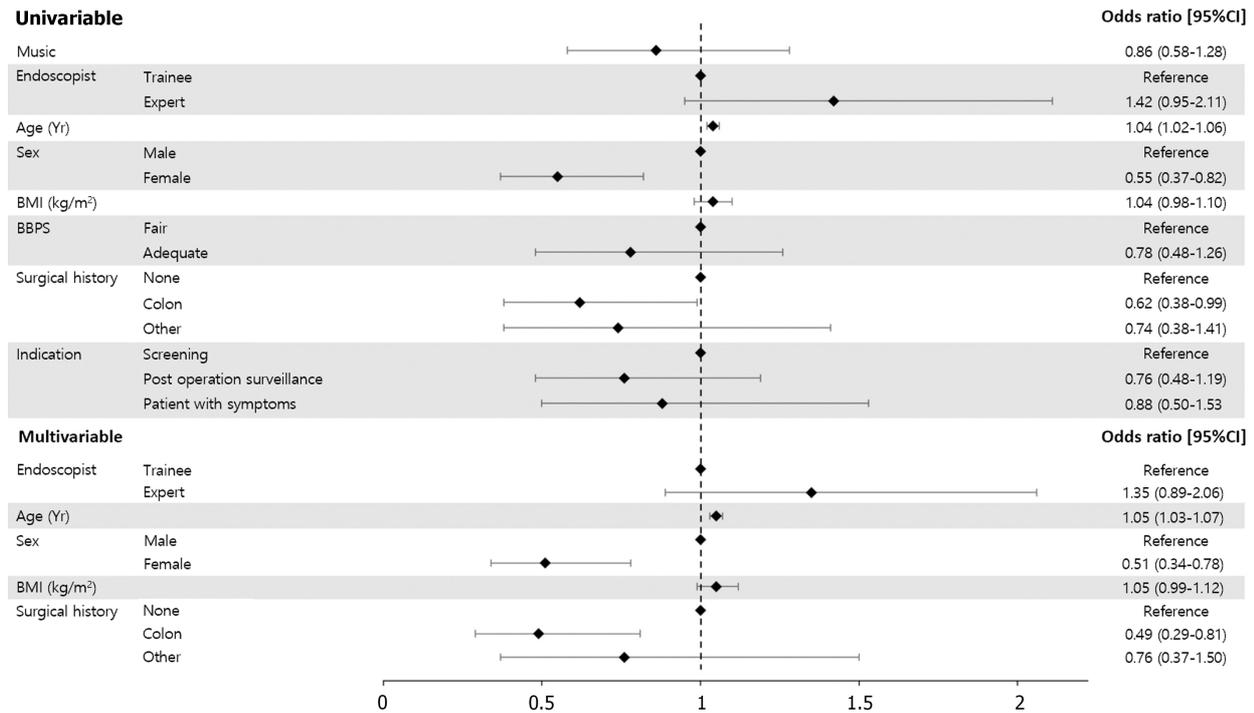
P value for independent variables from logistic regression analysis; No.: Number of patients; OR: Odds ratio; aOR: Adjusted odds ratio; CI: Confidence interval; BMI: Body mass index; BBPS: Boston Bowel Preparation Scale.

which contains mostly lyrics, classical, or Star Wars music has no lyrics. Although a preference for music with lyrics can bring psychological stability, it can actually be a hindrance in terms of improving concentration[15]. Moreover, the volume of the music can influence the efficacy of task performance. Music played too loudly can interfere with communication among operating room staff and act as noise [16], thereby increasing the risk of surgical site infection[17]. As such, we kept the music at 60 dB to facilitate communication.

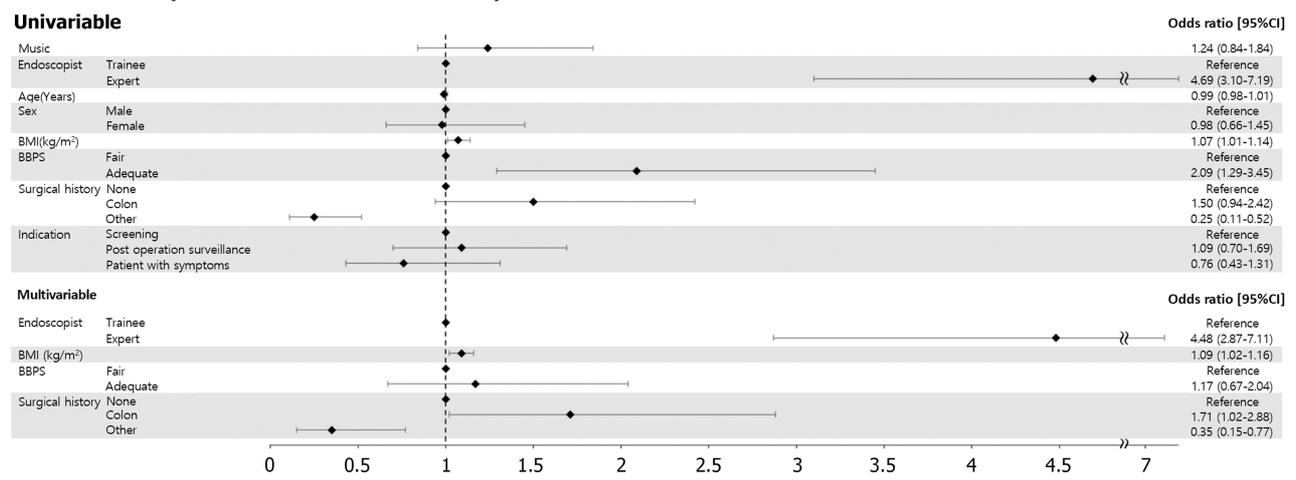
Trainees who listened to music had low PDR and ADR. This result was in contrast to that found in the expert group where no significant findings were noted. A previous study found similar results to those presented herein after examining the effects of music on novice surgeons[18,19]. They explained that music could have distracted surgeons as they performed new or complex tasks. These results can also be applied to endoscopy trainees. Endoscopy trainees are unfamiliar with endoscopic manipulation and require frequent assessment of the patient's condition, which inevitably consumes their attention, with music possibly making this situation worse.

The quality of colonoscopy is best determined by the ADR. Variables that can influence the ADR include age, sex, bowel preparation, and endoscopist experience[20]. The current study showed that age, sex, and surgical history were independent prognostic factors for adenoma detection. The ADR and age were positively correlated, with men having higher ADRs than women[21]. A history of abdominal or pelvic surgery makes colonoscopy difficult[22]. In particular, colon surgery affects insertion time, and prolonged insertion time reduces ADR[23,24]. A significant difference in the baseline characteristic of surgical history for colonoscopy was observed between the two groups. However, propensity score

**A Adenoma detection**



**B Fast insertion (< median insertion time of 310 s)**



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**Figure 1 Forest plot for the prognostic factor of colonoscopy performance.** A: Adenoma detection; B: Fast insertion. BMI: Body mass index; BBPS: Boston Bowel Preparation Scale; 95%CI: 95% confidence interval.

matching was performed to minimize the differences in factors that may affect colonoscopy performance.

The role of music in medicine has been growing and expanding. Evidence has shown that music may reduce congestive heart failure by reducing plasma cytokine and catecholamine levels, thereby enhancing parasympathetic activity[25]. Moreover, it influences brain activation and can be helpful in neurorehabilitation[26]. As such, we sought to determine how these positive effects of music might affect colonoscopy performance. Safe, high-quality colonoscopy is important for colorectal cancer screening and diagnosis, as well as treatment of colorectal diseases. High-quality colonoscopy by endoscopists can reduce the incidence of intermittent cancer[27]. However, colonoscopy is a relatively invasive procedure that can cause complications and pain in patients and requires high concentration by endoscopy specialists[28]. Although studies have confirmed the positive effects of music in patients undergoing colonoscopy, no data have been available regarding its effects on the operator. Through this study, we confirmed that music did not have a significant effect on the performance of colonoscopy. Nonetheless, we expect that more studies will be conducted on this matter based on our findings.

The current study has some limitations worth noting. First, given the retrospective nature of our study, selection bias may have occurred. To reduce this bias, we created two groups by matching patients according to indications, age, and sex after they had started listening to music during

colonoscopy at the hospital. A randomized study on the effect of music on colonoscopy is needed in the future. Second, the segmentation of abdominal surgery history was insufficient. Although gastric and pelvic surgery may have different effects on colonoscopy performance, we did not divide our patients according to surgery type. Given that pelvic surgery is mostly conducted among women, sex differences should be analyzed; however, the insufficient number of patients prevented us from doing so. Third, the genre of music was limited. While the most preferred and familiar Korean pop music was selected, diversifying the music is necessary considering that the presence of lyrics and music genre may affect colonoscopy performance.

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## CONCLUSION

In conclusion, listening to music during colonoscopy did not affect procedure performances. Moreover, our findings suggested that listening to music during colonoscopy can distract trainee's ability to detect adenomas and polyps.

## ARTICLE HIGHLIGHTS

### **Research background**

Music has been used to improve task performance and relieving the surgeon's tension in operating rooms. There are no studies related to the effects of music on the performance of endoscopists.

### **Research motivation**

The role of music in medicine has been growing. Listening to music during colonoscopy affect performance of endoscopists.

### **Research objectives**

The study aimed to assess the effects of music on colonoscopy performance outcomes.

### **Research methods**

We retrospectively reviewed patients who underwent colonoscopy performed by endoscopists with popular music. Colonoscopy performance outcomes, such as cecal insertion time, adenoma detection rate (ADR), were compared between the music and non-music groups. The study was performed by propensity score matching to reduce selection bias.

### **Research results**

After one-to-one propensity score matching, 169 colonoscopies were selected for each group. The cecal insertion time and ADR did not significantly differ between both groups. In trainees, ADR (25.9% *vs* 47.6%,  $P = 0.006$ ) were significantly lower in the music than in the non-music group.

### **Research conclusions**

The current study found that listening to music during colonoscopy did not affect procedure performance. Moreover, it suggested that music may distract trainees from appropriately detecting adenomas.

### **Research perspectives**

A randomized study on the effect of music on colonoscopy is needed in the future.

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## FOOTNOTES

**Author contributions:** Lee HS contributed to study design, acquisition and critically reviewed the manuscript; Choi EJ contributed to the data interpretation, and drafting the manuscript; Lee HS, Yoon JS, Yu SJ and Lee JH performed the endoscopy; Yi SW contributed to statistical analysis; Lee HS, Choi EJ, and Lee HB edited the manuscript; Kim MP and Chung BC collected data; Jee SR and Lee SH provided clinical advice and supervised the report; and all authors have read and approve the final manuscript.

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