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ORIGINAL ARTICLE

The efficacy of rhomboid intercostal block for pain management after video-assisted thoracoscopic surgery: a prospective, randomized-controlled trial

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Abstract

Objective We aimed to evaluate the efficacy of rhomboid intercostal block (RIB) for analgesia management in patients who underwent video-assisted thoracoscopic surgery.

Methods Adult patients who underwent VATS under general anesthesia between July 2020 and June 2022 were included in the study. There was two groups in this study: RIB ($n = 25$) vs control ($n = 25$) group. RIB was performed with 30 ml 0.25% bupivacaine at the end of the surgery. Surgical intercostal blockade was performed with 30 ml 0.25% bupivacaine in the control group. The patients received intravenous fentanyl patient-controlled postoperative analgesia. The numerical rating score (NRS), opioid consumption, and adverse events were recorded.

Results A total of 50 patients were randomized into 2 groups. There were no significant difference in terms of the demographic data between groups ($P > 0.05$). Postoperative opioid consumption at 0–8, 8–16, 16–24, and 24–48 h and rescue analgesic use were significantly lower in RIB group ($P < 0.05$). At all times, the static/dynamic NRS were significantly lower in RIB group. The rate of nausea and itching was higher in control group ($P < 0.05$).

Conclusion US-guided RIB provides effective post-VATS analgesia.

Keywords Rhomboid intercostal block · Intercostal block · Video-assisted thoracic surgery · Postoperative analgesia

Introduction

The video-assisted thoracoscopic surgery (VATS) procedure is a minimally invasive surgical approach performed for thoracic procedures and lung diseases. VATS lends itself to reach the mass or pathology via small incisions. Due to its advantages over open thoracotomy, it is performed using thoracoscopes, and is widely used for lung resections such as segmentectomy, wedge resection or lobectomy [1, 2]. As a minimal invasive surgery which provides rapid recovery and early mobilization, VATS is a minimally invasive procedure that causes serious pain due to the rib retractors and insufflation of the thoracic cavity [3, 4]. Since pain relief reduces opioid consumption and boosts postop recovery quality, the enhanced recovery after surgery (ERAS) protocol recommends effective multimodal pain management after VATS [5].

Ultrasound (US) guided regional block methods constitute an important role in postoperative multimodal analgesia protocols in recent years [6–8]. Several methods may be performed for pain relief after VATS [3, 9, 10]. For instance, the rhomboid intercostal block (RIB) proposed by Elsharkawy et al. (2016) is performed into the fascial plane between the rhomboid major (RMm) and intercostal muscles (ICm) at the level of T5–T6 just near the medial border of the scapula, providing anterolateral and posterior thoracic analgesia [11–13]. Several studies and case reports have demonstrated RIB can provide effective post-VATS analgesia [14–19].

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Moreover, RIB is deemed a safe method and far from the incision site for VATS [16]. Nevertheless, the number of RCTs regarding the efficacy of RIB are limited. There is still the need for prospective randomized clinical studies which assess analgesic RIB efficacy for VATS. That said, the number of a prospective study comparing the postoperative analgesia efficacy of RIB with control group after VATS is limited.

In this study, our hypothesis was that, compared to a control group, RIB would provide better post-VATS analgesia. We aimed to evaluate the efficacy of Us-guided RIB for postop analgesia management in patients who undergo VATS.

Materials and methods

Study design and participants

Approval for this prospective, a randomized trial was obtained from the Ethics and Research Committee of Istanbul Medipol University (16/06/2020, Decision No: E.17828). After approval, we registered the study at clinicaltrials.gov (NCT04428216). The study was conducted at Medipol Mega University Hospital between July, 2020 and June, 2022. Written consent forms were obtained from all participants who enrolled in the study before the operation.

The inclusion criteria of the study are as follows: (1) 18–65 years old, (2) American Society of Anesthesiologists (ASA) Class I–II, (3) patients who underwent a thoracoscopic wedge resection or a lobectomy.

The exclusion criteria of the study is as follows: (1) refusal to take part in the study; (2) allergic to local anesthetics (LA), opioids or nonsteroidal anti-inflammatory drugs; (3) a skin infection in the block area; (4) open thoracotomy; (5) the inability to use a patient-controlled intravenous analgesia (PCIA) device; and (6) coagulation abnormalities.

Randomization and grouping

Eligible patients were assigned randomly to the two groups, the RIB group and the control (C) group. Grouping and randomization were carried out with a randomization table created by a Research Randomizer software programmer. An anesthetist who did not partake in the trial assigned a random ID number to each participant, who were blinded as per their group.

Anesthesia (GA), intraoperative multimodal analgesia management, and surgery type

Participants were monitored in the surgery ward with standard ASA procedure (electrocardiography, pulse oximetry and non-invasive blood pressure). The same GA induction protocol was used in each group, and performed by means of intravenous (IV) administration of 2–2.5 mg/kg propofol, 1–2 mcg/kg fentanyl, and 0.6 mg/kg rocuronium bromide. A double-lumen left-sided, 35–37 French endotracheal tube was generally used for the intubation. The proper position of the double-lumen tube was checked with a fiberoptic bronchoscopy after intubation. The radial artery cannulation was carried out with a 20-gauge cannula for invasive blood pressure monitoring. Patients were placed in the lateral *decubitus* position with the surgical side up used for the operation. One-lung protective ventilation model settings were used for mechanical ventilation. The settings were: a tidal volume of 5–6 ml/kg, an end tidal CO_2 pressure of around 30 mmHg, and a peak airway pressure of around 25–30 cmH_2O. We utilized sevoflurane in a 50% air–oxygen mixture, and a remifentanil infusion at a rate of 0.05–1 mcg/kg/min for anesthesia maintenance. A remifentanil IV bolus injection (0.5 mcg/kg) was performed for additional analgesia whenever needed. All the participants were administrated IV 4 mg ondansetron, 400 mg ibuprofen, 100 mg tramadol, and 10 mcg fentanyl PCIA bolus prior to the end of the surgery for multimodal analgesia management and nausea/vomiting prophylaxis.

All surgeries were performed by the same surgical team. All operations were performed by VATS with two or three ports. A 24 F chest drain was inserted at the 7th/8th intercostal space in the midaxillary line at postop. The length of the incision was average 5–8 cm at the level of 5th intercostal space in the anterior axillary line. It was 5 cm for wedge resection, and 8 cm for lobectomy. We performed VATS only through monitor vision, we did not use direct vision. We used a wound opener during the surgery. The size of the ports was 10 mm. The placement of the ports was at the level of 7th intercostal space in the anterior axillary line and at the level of 9th intercostal space in the posterior axillary line. The average time for chest tube removal was within 48 h.

US-guided regional anesthesia technique

RIB was performed pre-extubation in the lateral decubitus position under US guidance with a high frequency transducer (11–12 MHz) covered with sterile sheath. RIB was performed post-skin sterilization with 10% povidone-iodine. The transducer was positioned in the oblique sagittal plane near the medial border of the scapula at the T5–T6 level. The trapezius, rhomboid major (RMm), intercostal muscles, pleura, and ribs were spotted as anatomical landmarks. An 80-mm, 22-G block needle was inserted with an in-plane technique in a craniocaudal direction. For confirmation, 5 ml of normal isotonic saline was administered between the RMm and the rib. A dose of 30 ml 0.25% bupivacaine was

administered here after confirming and spotting the needle tip between RMm and rib (Fig. 1).

The surgeon performed postop surgical intercostal blockade at the 4th, 5th, 6th levels with 30 ml of 0.25% concentration bupivacaine on patients in the Group C.

The participants with sufficient spontaneous respiration were extubated after block procedure, then transferred to the intensive care unit (ICU) postop.

Postoperative analgesia management protocol and assessment of outcomes

We used our standard postoperative analgesia management protocol for the study. All patients received 400 mg of ibuprofen IV every 8 h after the surgery. A PCIA device (10 mcg/ml fentanyl) was attached to all patients: a self-bolus dose of 2 ml, 20 min lockout period, and no background infusion. Blindfolded to the grouping, the pain nurse anesthetist evaluated the postoperative pain using the 11-point numerical rating scale (NRS), ranging from 0 (no pain) to 10 (unimaginable pain). The pain scores were assessed postop at 1, 2, 4, 8, 16, 24, and 48 h. The analgesic PCIA pump was used by the patient if needed. Rescue analgesia with additional meperidine of 0.5 mg/kg was administered if the NRS was ≥ 4.

While the primary outcome of the study was total opioid consumption in the postoperative 48 h, the secondary outcomes of the study were: static (at rest) and dynamic (during cough), need for rescue analgesia, and rate of adverse events related to opioids (nausea, vomiting, itching).

The blindfolded pain nurse anesthetist evaluated and recorded the outcomes.

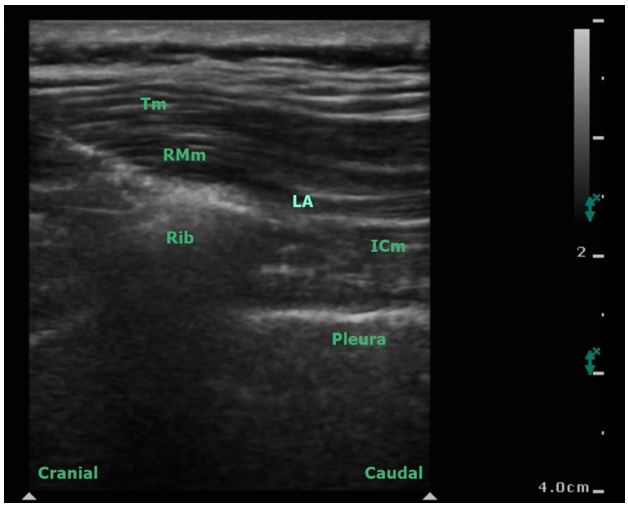

Fig. 1 Sonographic visualization of rhomboid intercostal block. Trapezius, rhomboid major, and intercostal muscles are seen. The spread of local anesthetic is seen between the RMm and ICm just above the rib. The needle direction is from cranial to caudal direction. The rib plays an important barrier role in front of the pleura. Tm; trapezius muscle, RMm; rhomboid major muscle, ICm; intercostal muscle, LA; local anesthetic

Sample size calculation

The sample size of the study was calculated using the G*Power program (V.3.1.9Heinrich-Heine-Universidad Dusseldorf, Germany) based on a preliminary study in our clinic with eight patients in each group. A minimum 20% reduction in postop total opioid consumption (PCIA fentanyl) at the postop 24th h was accepted as clinically significant. The average total opioid consumption was 30 ± 17 mcg in the RIB group and 57 ± 26 mcg in the control group. Twenty-two participants were needed per each group, assuming a two-sided type I error of 0.01, along with type II error of 0.10 which eventually brings a power of 0.90 (1-β). In taking possible drop-outs into consideration, we decided to include a minimum of 25 patients per group.

Statistical analyses

Regardless of whether the observation was normal or skewed, the distribution shapes of variables used in this study were assessed by means of the Shapiro–Wilk test. In cases where test results indicated the data were normally distributed, data were detailed with an average ± SD, then analyzed by an independent sample *t* test to compare group-wise differences to outcome parameters. The continuous data that yielded non-parametric dispersion were detailed with median and IQR, and analyzed by means of the Mann–Whitney *U* test to observe group-wide differences. Statistical analyses were conducted using SPSS V.25 (SPSS, Chicago, Illinois, USA).

Results

From the CONSORT flowchart of this study in Fig. 2, it is seen that a total of 72 patients were monitored to determine their eligibility for the study. Fifteen patients did not meet the inclusion criteria, 4 patients refused to participate, whereby the remaining 53 participants were divided into two groups. While two patients in RIB group experienced PCIA failure, one patient also suffered the same failure in the control group. In the end, 25 patients were analyzed per group. There were no differences in terms of baseline characteristics (age, gender, height, weight, anesthesia and surgery time) between groups. While VATS procedures in our study were wedge resection and lobectomy, there were no differences in terms of the surgical procedure (Table 1).

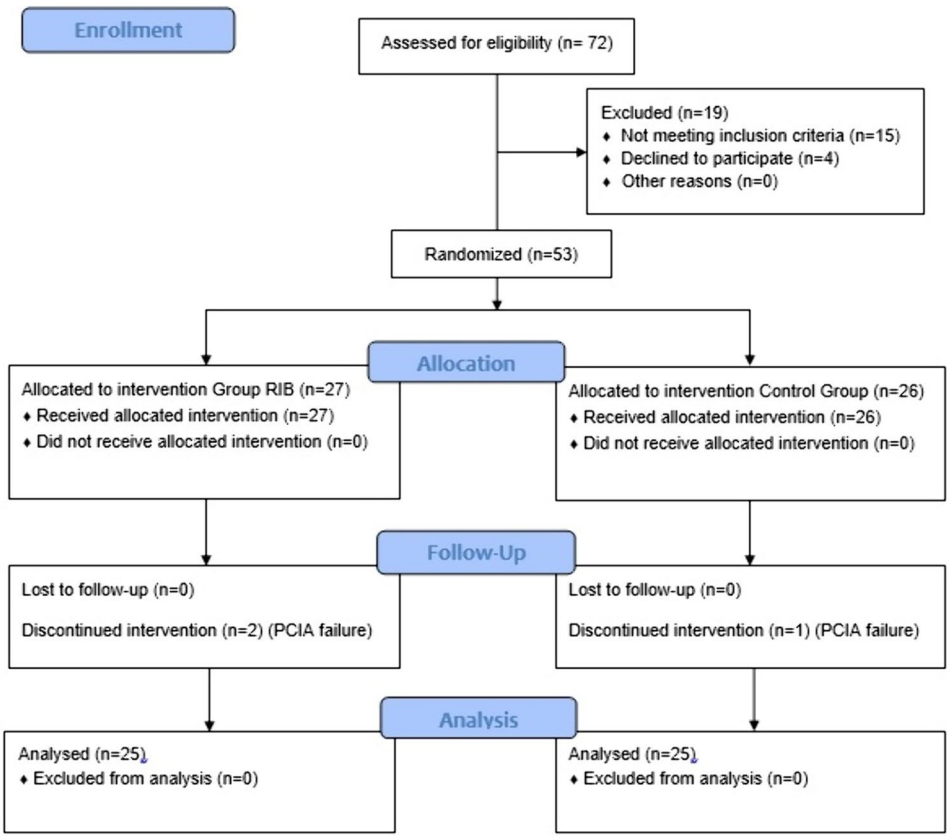

Fig. 2 CONSORT flow diagram of the study

Table 1 Demographic data and duration times of surgery and anesthesia

	Group RIB ($n = 25$)	Group control ($n = 25$)	P
Age (years)	48 (39–54)	41 (37–51)	0.248*
ASA (I/II)	10/15	12/13	0.569†
Gender (M/F)	15/10	14/11	0.774†
Height (cm)	170 (160–175)	170 (160–172)	0.647*
Weight (kg)	78 (66–85)	77 (65–82)	0.838*
Surgical type (wedge resection/lobectomy)	13/12	15/10	0.569†
Anesthesia time (min)	160 (150–180)	160 (140–190)	0.861*
Surgical time (min)	135 (120–150)	140 (120–170)	0.586*

Values are expressed mean ± standard deviation or number

kg; kilogram, cm; centimeter, M; male, F; female, min; minutes, ASA; American Society of Anesthesiologist

*P value is obtained with t test (mean±SD)

†P value is obtained with Pearson's χ^2 test (n)

In terms of opioid consumption (fentanyl PCIA), there were significant differences between groups. Compared to the control group at the postop 48-h period, the fentanyl consumption from PCIA device was significantly lower in the RIB group. While the 48-h total fentanyl PCIA consumption was 20 (20–40) mcg in the RIB group, it was 80 (50–100) mcg in the control group ($P = 0.001$) (Table 2). Compared to the control group, the need for rescue analgesia (meperidine) was significantly lower in the RIB group. The number of patients requiring meperidine was 6 in RIB group, and 12 in control group ($P = 0.001$) (Table 2).

In terms of NRS between groups, there was significant differences at postop 1, 2, 4, 8, 16, and 24 h. Both the static and dynamic NRS were lower in the RIB group compared to the control group ($P < 0.05$) (Table 3).

The rate of nausea and itching side effects was significantly higher in the control group compared to the RIB group. While six patients in the RIB group, and ten patients in the control group suffered from nausea ($P = 0.021$), three patients in the RIB group, and nine patients in the control group experienced itching ($P = 0.024$). In terms of vomiting, there was no difference between groups (4 vs. 9 patients in RIB and control groups, respectively) ($P = 0.107$) (Table 4).

Discussion

This trial was designed to evaluate postop analgesic efficacy of the RIB against the control groups in patients who underwent VATS. According to our results, RIB provided effective postop analgesia and lower pain scores, decreased opioid consumption, and the need for rescue analgesia.

Table 2 Comparison of opioid (fentanyl PCIA) consumptions and the need for rescue analgesia (meperidine) between groups

	Group RIB ($n = 25$)	Group control ($n = 25$)	P*†
Time intervals			
0–8 h (mcg)	20 (0–20)	40 (20–40)	**0.001**
8–16 h (mcg)	0 (0–20)	20 (20–40)	**0.001**
16–24 h (mcg)	0 (0–0)	10 (10–10)	**0.001**
24–48 h (mcg)	0 (0–0)	10 (0–10)	**0.002**
Total (mcg)	20 (20–40)	80 (50–100)	**0.001**
Rescue analgesia (Y/N)	6/19	12/13	**0.001**

Data are expressed as a median (min-max) or number. *P* values that are written in bold represent statistical significance.

Mcg microgram, *Y* yes, *N* no

* *P* value is obtained Mann–Whitney *U* test (median (IQR)

† *P* value is obtained with Pearson's χ^2 test (*n*)

Table 3: The average numerical rating scale scores during postoperative first 48 h

Hour	Group RIB ($n = 25$)	Group control ($n = 25$)	P*
NRS static (rest)			
1	1 (0–2)	3 (3–4)	**0.001**
2	1 (0–1)	3 (3–3)	**0.001**
4	1 (0–1)	2 (2–3)	**0.001**
8	1 (0–2)	3 (2–3)	**0.001**
16	0 (0–1)	2 (2–4)	**0.001**
24	0 (0–0)	2 (1–2)	**0.001**
48	0 (0–0)	1 (0–1)	0.372
NRS dynamic (cough)			
1	2 (1–3)	5 (4–5)	**0.001**
2	1 (1–2)	3 (3–4)	**0.001**
4	1 (0–2)	3 (3–4)	**0.001**
8	1 (0–2)	3 (3–3)	**0.001**
16	1 (0–2)	3 (2–4)	**0.001**
24	0 (0–0)	2 (2–3)	**0.001**
48	0 (0–0)	1 (1–2)	0.476

Data are expressed as median (percentiles 25–75). *P* values that are written in bold represent statistical significance.

* *P* value is obtained with Mann–Whitney *U* test. Median (IQR)

NRS numerical rating scale

Table 4 Incidence of adverse effects

	Group RIB ($n = 25$)	Group control ($n = 25$)	P†
Nausea (Y/N)	6/19	10/15	**0.021**
Vomiting (Y/N)	4/21	9/16	0.107
Itching (Y/N)	3/22	9/16	**0.024**

Bold values are statistically significant

† *P* value is obtained with Pearson's χ^2 test (n)

Y; yes, N; no

Furthermore, the rate of adverse events was lower in the RIB group.

Particularly in recent years, interfacial plane blocks have been a groundbreaking and popular topic in the field of anesthesia [6, 20]. RIB is an interfacial plane block and it was described by Elsharkawy et al [11]. It provides hemithoracic analgesia between T2 and T9 dermatomal levels by injecting the LA between RMm and intercostal muscles. The dye spread of RIB between T2 and T8 planes was shown in a cadaveric study [12]. The RIB has consistent spread to dorsal rami [21, 22]. As the lateral branches of the intercostal nerves at the level of T3–T8 are blocked by RIB, two or three port approaches are commonly used in thoracoscopic surgery [11, 12, 21]. Since the incision sites of the ports are usually found at the level of the 5th, 8th, 9th intercostal spaces, the RIB is effective for analgesia management in post-VATS due to the dermatomal coverage between T2 and T9 [16, 21]. There are several case reports and studies found in the literature showing the efficacy of RIB for VATS. Postop analgesia post-VATS management is crucial due to the unwanted complications caused by insufficient analgesia, whereby successful analgesia management provides earlier mobilization and enough coughing. Since there is no or less pain during coughing, the incidence of lung-related complications such as atelectasis in patients is lessened [16]. Moreover, early mobilization reduces the rate of thromboembolic complications. Since chest wall drainage tubes are used post-VATS, pain rendered from pleural and intercostal irritation is commonly seen [3, 4, 16]. Severe coughing may increase related to chest-tube-induced pain. Surgical incisions, port sites, and nerve damages can also lead to mild-to-severe pain after thoracoscopic surgery [3, 4, 16]. Opioid agents are commonly used for pain relief after surgery. However, they have adverse effects such as respiratory depression, nausea, vomiting, and allergic reactions [3, 4]. Thus, it is necessary to utilize a regional technique as a part of multimodal analgesia protocol post-VATS. Both

the static and dynamic NRS in the RIB group were lower than the control group in our study. The RIB also decreased opioid consumption at the postop period.

In a case report, Çiftçi et al. performed RIB in three patients who underwent VATS. They administrated 30 ml 0.25% concentration bupivacaine, and reported that pain scores were <3, and there was no need for additional analgesic [18]. In a prospective randomized trial, Wang et al, compared RIB and thoracic paravertebral block (TPVB) for postop recovery quality post-VATS [16]. They reported that RIB was non-inferior to TPVB in terms of recovery quality. In utilizing Quality of Recovery-40 (QoR-40) questionnaire to evaluate the postop patient recovery scores, they found no differences in terms of QoR-40. The authors performed the blocks with 20 ml volume. While TPVB was the gold standard for thoracic analgesia in this study, RIB provided equally effective analgesia. In another prospective randomized-controlled trial, Deng et al. compared RIB vs RIB + subserratus block (RISS), and control group post-VATS. In reporting both RIB and RIB + RISS provided effective analgesia compared to the control group, they also highlighted the fact that RIB + RISS was superior to RIB [15]. They performed RIB with 20 ml volume and RIB + RISS with 40 ml volume. While the efficacy of interfacial plane blocks is volume dependent, the difference may be due to that of the applied volumes. Unlike this study, we performed 30 ml volume of RIB in our trial. In a prospective study, Wang et al. compared RIB, TPVB, and control group after VATS [19]. They found that both RIB and TPVB groups were better than control group in terms of pain scores, opioid consumption, and QoR-15. They reported that compared with TPVB, RIB had a better analgesic effect, whereby the procedure of RIB is more simple and safe. Zhang et al. compared erector spinae plane block (ESPB), RIB, and serratus anterior plane block (SAPB) on analgesia for VATS [14]. In performing 20 ml of LA per each group, they reported both ESPB and RIB provided effective analgesia compared to SAPB in the postop 24 h period. Unlike this study, we performed 30 ml volume. To better understand the ideal analgesic choice for VATS, it would be suitable to compare various volumes of RIB with different regional anesthesia techniques. As for the efficacy and safety of RIB for analgesia in breast surgery and VATS meta-analysis, the authors reported that RIB was more effective in analgesia management post-breast surgery and VATS [21]. They also underscored that RIB is an effective and safe block technique. The application area of RIB is more peripheral than ESPB and TPVB. As a result, the LA spreads to the lateral branches of the intercostal nerves rather than the epidural and paravertebral space. Therefore, RIB may provide more focused analgesia than ESPB and TPVB post-VATS [21, 22]. Furthermore, hypotensive complications may be less common in RIB. We performed 30 ml RIB, and in line with the literature, the pain scores and the opioid consumption were lower in RIB group in our study. In the literature, there is still no study that compares RIB vs control on post-VATS analgesia.

There are some limitations in our study. For instance, we used 30 ml volume of LA. Different results may be achieved with different volumes; our sample size was relatively small. Studies with larger sample sizes are needed. Also, we did not evaluate the dermatome levels, which are needed to better understand the efficacy of RIB. Lastly, while we performed single-shot block, studies with continuous infusion may be performed.

Conclusion

In summary, RIB provided adequate pain relief in patients subject to VATS. The pain scores and opioid consumption were lower compared to the control group. RIB may be a simple, effective, and safe analgesic technique for VATS.

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Data availability The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request

Declarations

Conflict of interest The authors declare no conflicts of interest.

Ethics approval and consent to participate This study has been approved by Istanbul Medipol University Ethics and Research Committee (16/06/2020, Decision No: E.17828). All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication Written informed consent was obtained from the participants.

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