Original article

Comparison of 3 techniques in percutaneous tracheostomy: Traditional landmark technique; ultrasonography-guided long-axis approach; and short-axis approach – Randomised controlled study

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A B S T R A C T

Introduction: The aim of this study is to compare the reliabilities of the traditional landmark method, ultrasonography-guided long-axis in-plane application, and ultrasonography-guided short-axis out-of-plane application in percutaneous dilatational tracheostomy.

Patients and methods: A total of 60 patients were divided in 3 random groups undergoing percutaneous tracheostomy by using landmark method, ultrasonography-guided out-of-plane method, and ultrasonography-guided in-plane method. While demographic data of the patients were recorded before the procedure, number of punctures, success rate at the first entry, rate of successful tracheostomy tube placement, total tracheostomy time, and complications were recorded during and after the procedure.

Results and discussion: It was found that 23 women and 37 men were included in the study, the average age of the cases was 68.0 ± 15.5; mean body mass index was 27.9 ± 4.3; mean APACHE II scores were 27.4 ± 4.6 and there was no significant difference between the groups in terms of demographic data. The ultrasonography-guided out-of-plane application had significantly lower number of punctures, higher first entry success, and fewer complications compared to the other groups. Independently from the groups, first entry success was significantly low in advanced age and number of punctures significantly increased the complication rate.

Conclusion: In this randomised controlled study, it was found that ultrasonography-guided out-of-plane application had lower number of punctures, higher first entry success rate, and less complications. It was observed that advanced age negatively affected the first entry success and as number of punctures increased, the complication rate increased. ClinicalTrials.gov ID: NCT02855749.

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1. Introduction

Intensive care patients frequently need tracheostomy for long-term ventilator support. Although superiority of tracheostomy to long-term orotracheal intubation remains controversial [1], percutaneous dilatational tracheostomy (PT) has some advantages [2]. These advantages are:

- high patient comfort and airway safety;
- better cleaning of the airway;
- allowing oral nutrition and speech;

- reduce sedation need;
- earlier weaning planning and discharge [3].

Despite low complication rates, severe side effects and even death are reported. According to Simon et al., PT-related deaths are seen in 1 of every 600 patients undergoing PT [4]. In total, 31% of these deaths are secondary to PT-related haemorrhages and develop during the practice. The second leading cause of death is airway complications (29.6%).

The use of ultrasonography (USG) before, during, and after PT provides advantages such as the anatomy of pretracheal and paratracheal areas, the imaging of potential aberrant veins and thus the removal of the needle and dilators from risk areas, and the prevention of possible vascular complications [5]. Also, the distance from the skin to the trachea can be measured and this helps select the suitable size of tracheostomy tube. It can be used to
explicitly view the tracheal rings required for the suitable place of tracheal intervention and to confirm the midline placement [6].

In the literature, it is observed that PT is generally applied by using the traditional landmark method. Many studies in the literature have shown that ultrasonography can be applied safely in PT [6–10] and in some studies, it is argued that the combined use of long and short axes is more reliable [10]. But no comparison of these three methods was found.

The aim of the present study is to compare the first entry success, number of punctures, complication rates, time of tracheostomy and successful tube placement of the traditional landmark method, ultrasonography-guided long-axis in-plane application and ultrasonography-guided short-axis out-of-plane application in PT.

2. Material and method

This open, single-centred randomised controlled study was conducted in the reanimation unit of Erzincan university, Mengüce Gazi Training and Research Hospital. It was completed within 6 months once the ethics committee approval from Erzincan university and written consents from the legal heirs of the patients were obtained. ClinicalTrials.gov ID: NCT02855749.

A total of 60 patients, who were hospitalised in the intensive care unit, mechanically ventilated, from both sexes, prolonged or contemplative orotracheal intubation time, were 18 years old and for whom the decision of PT was made, were included in the study. The PT indications of the patients were as follows; having acute respiratory insufficiency, not being able to be safely separated from the mechanical ventilator, and having a chronic disease to be treated via tracheostomy.

The patients, who were under 18 years old, expected early extubation, had high or unstable intracranial pressure, had severe coagulation disorder (because of the bleeding), were wearing a neck collar (patients at risk for positioning the neck), were haemodynamically unstable despite the use of high-dose vasoactive drugs (sedative and muscle relaxant drugs have negative effects on haemodynamics), and had infections in tracheostomy area, were excluded from the study.

Decision and timing of PT were determined according to the clinical decision of the doctor.

At the beginning of the study, the patients were randomly divided into 3 groups after their demographic data such as age, gender, body mass index (BMI), APACHE II scores, international normalisation ratio (INR) and platelet number, number of ventilator days before tracheostomy, and diagnoses were recorded.

Group 1: landmark group (n: 20): the group undergoing PT by using traditional landmark technique.

Group 2: ultrasonography-guided short-axis out-of-plane group (n: 20): PT was applied as out-of-plane by using ultrasonography-guided real-time short-axis imaging method.

Group 3: ultrasonography-guided long-axis in-plane group (n: 20): PT was applied as in-plane by using ultrasonography-guided real-time long-axis imaging method.

Before the procedure, deep sedation and analgesia and then rocuronium as neuromuscular blocking agent were administered to all the patients, they were ventilated in volume control mode with 100% FiO₂ and continuous haemodynamic monitoring was performed (electrocardiogram, blood pressure, heart rate, and peripheral oxygen saturation).

2.1. Landmark technique

After induction and position, the bedside doctor (AN) pulled the endotracheal tube until the balloon came near to the vocal cords via direct laryngoscopy. Sternal notch, thyroid and cricoid cartilages and midline trachea were marked by palpation performed by a second doctor (IK) who would perform PT. The space between the first and second tracheal rings, or second and third tracheal rings was selected for the placement of the tracheostomy tube [11]. A puncture needle was inserted perpendicularly in the skin via an injector filled with saline. While the needle was passing through the anterior wall, a change was felt in resistance and lumen was entered subsequent to the air/water aspiration of the injector. Then, the needle was directed to the caudal in order to prevent the retrograde intubation of the guide wire. The guide wire was pushed forward and the needle was drawn back. After the cannula insertion site was diluted with the help of a curve dilator, the tracheostomy cannula was placed [11].

2.2. Ultrasonography-guided out-of-plane (short-axis) PT technique

After induction and position, the endotracheal tube was retracted until the cuff was just under the vocal cords via direct laryngoscopy. High-frequency linear probe (Sonosite M-Turbo, Sonosite, USA) in the sterile cuff was transversely placed in order to view the upper respiratory tract and it was brought down to the thyroid gland and isthmus, starting from the hyoid bone. By sliding the probe towards the caudal, cricoid cartilage was identified. As it was moved towards the caudal of the cricoid cartilage, the tracheal rings were seen. The trachea was identified on the midline between the first and second rings, or second and third rings. The needle was inserted perpendicularly and lumen was entered after the air/water aspiration of the injector. The needle was viewed in out-of-plane mode. Then, the ultrasound probe was removed and the injector was separated. The guide wire from the tracheostomy kit was moved forward inside the needle across trachea. After the cannula entry site was diluted with the help of the curve dilator, the tracheostomy cannula was inserted [12].

2.3. Ultrasonography-guided in-plane (long-axis) PT technique

Through the long-axis application, midline position of the trachea was identified firstly. Thyroid cartilage, cricoid cartilage and 1–5 tracheal rings were identified. The needle was inserted as in-plane from the edge of the probe with an angle of 90 degrees and directed towards the caudal. Under real-time long-axis imaging, the needle was passed between the 1st or 2nd tracheal ring and confirmed with air aspiration. The guide wire was passed through the needle. The procedure was completed as previously mentioned [10].

The status of the tracheostomy tube cuff, posterior wall injury, and guide wire position were evaluated in both ultrasonographic methods. The accuracy of the tube placement, chest auscultation, and mobility of lungs were observed via USG. It was observed that the mobility of the lung was viewed as the prolapse of the visceral pleura in parietal pleura in the intercostal interval in M mode [9].

Tracheostomy was performed with the forceps dilatation (Griggs) method in all patients. The Griggs method uses “Howard-Kelly” forceps for dilatation. The guide wire is inserted through the hole at the end of the forceps, the subcutaneous tissue and trachea are diluted with the forceps.

All tracheostomy applications were performed by the 1st author (IK), who performed each method at least 20 times before.

During and after the application, the number of punctures, success rate of first entry, rate of successful tracheostomy tube placement, and total tracheostomy time were recorded in all the patients. In addition, the anatomic variations of the trachea and aberrant veins, if any, were recorded before the application in ultrasonography group. Complications during and after the application (minor bleeding, major bleeding, haematoma, subcutaneous...
emphysema, pneumothorax) were recorded. Doppler ultrasonography was used when needed.

Bedside chest radiographies of all the patients were taken after the application.

The patients were followed up for 1 month after the procedure and early and late complications induced by the application were recorded. Complications seen in the first hour were taken as early complications. For example; major bleeding, major bleeding, paratracheal placement, haemodynamic instability, desaturation, and subcutaneous emphysema. Late complications were accidental decannulation, pressure ulcer, haemorrhage, and infection.

Primary outcome of the present study was determined as the first entry success for all three groups.

Secondary outcomes were determined as complications during the procedure for all three groups. Complications during the procedure were minor bleeding, major bleeding, subcutaneous emphysema, pneumothorax, and desaturation. Number of punctures, total tracheostomy time, successful tube placement rate, and early and late complication rates after the procedure were determined as secondary outcomes, too.

2.4. Statistical analysis

The power of the study was calculated based on the study by Rudas et al. [13] in which the first entry success in USG-guided PT was observed as 87%. In the present study, the first entry was predicted as 80%. Accordingly, the strength value of 85% was obtained by using the Tukey–Kramer (binary) multiple comparison test at the significance level of P < 0.0500 in the three groups with sample size of 20, 20, and 20.

All data were analysed using the Statistical Package for Social Sciences (SPSS Inc., Chicago, IL) version 23.0 program. A one-way Anova test was applied to the variables of the tracheostomy and total period meeting normal distribution. The Kruskal–Wallis test, a non-parametric test, was applied to the variables of first entry success and number of punctures not meeting the normal distribution. The Mann–Whitney U test was used to find out the group causing the difference between the groups in terms of first entry success and number of trials. For multiple comparisons, a post-hoc analysis was used. Because the presence of complications was a categorical variable, a Chi² test was applied. A Pearson correlation test was applied in order to determine the factors affecting the success independently from the group. Statistical significance level was accepted as P < 0.05 in all the analyses.

3. Results

3.1. Demographic data

A total of 60 patients were included in the study. There was no difference between the groups in terms of gender, in the study including 23 women and 37 men. The patients were minimum 18 and maximum 89 years old. In between-groups comparison, no difference was observed in terms of age. The body mass index (BMI) of the patients was on average 27.9 ± 4.3 and there was no difference between the groups. When APACHE II assessments were considered, it was observed that the mean value was 27.4 ± 4.6 and there was no difference between the groups. There was no significant difference between INR and platelet count of the groups (Table 1).

Four patients had BMI > 33 kg/m² and a short neck. The trachea deviated due to thyroid enlargement in one patient and two patients had difficulty in giving longitudinal position due to rheumatoid spondylitis.

### Table 1

<table>
<thead>
<tr>
<th>Group</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Mean</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>8/12</td>
<td>7/13</td>
<td>8/12</td>
<td>23/37</td>
<td>0.932</td>
</tr>
<tr>
<td>Age</td>
<td>71.0 ± 12.5</td>
<td>69.0 ± 16.3</td>
<td>64.2 ± 17.4</td>
<td>68.0 ± 15.5</td>
<td>0.462</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>28.8 ± 4.5</td>
<td>28.6 ± 4.4</td>
<td>26.3 ± 3.7</td>
<td>27.9 ± 4.3</td>
<td>0.802</td>
</tr>
<tr>
<td>APACHE II</td>
<td>27.9 ± 4.3</td>
<td>26.3 ± 4.9</td>
<td>27.8 ± 4.8</td>
<td>27.4 ± 4.6</td>
<td>0.389</td>
</tr>
<tr>
<td>INR (sn)</td>
<td>1.21 ± 0.2</td>
<td>1.14 ± 0.1</td>
<td>1.22 ± 0.4</td>
<td>1.19 ± 0.2</td>
<td>0.652</td>
</tr>
<tr>
<td>Platelet</td>
<td>287.7 ± 230.8 ± 62.0 ± 242.5 ± 105.0 ± 253.7 ± 150.2 ± 481</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

F/M: female/male; BMI: body mass index; INR: international normalisation ratio.

* One-way Anova + Chi² tests.

### Table 2

<table>
<thead>
<tr>
<th>Group</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>Mean</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tracheostomy time (day)</td>
<td>10.1 ± 4.2</td>
<td>12.6 ± 4.2</td>
<td>11.7 ± 5.8</td>
<td>11.4 ± 4.8</td>
<td>0.124</td>
</tr>
<tr>
<td>Number of punctures</td>
<td>1.6 ± 0.5</td>
<td>1.2 ± 0.5</td>
<td>1.6 ± 0.6</td>
<td>1.5 ± 0.6</td>
<td>0.039b</td>
</tr>
<tr>
<td>Success of the first entry (n%)</td>
<td>8/40</td>
<td>17/85</td>
<td>10/50</td>
<td>0.010b</td>
<td></td>
</tr>
<tr>
<td>Total period (min)</td>
<td>7.3 ± 1.3</td>
<td>6.7 ± 1.3</td>
<td>7.1 ± 1.5</td>
<td>7.0 ± 1.4</td>
<td>0.507</td>
</tr>
<tr>
<td>Complication rate (n/10)</td>
<td>12/60</td>
<td>5/25</td>
<td>7/35</td>
<td>0.034b</td>
<td></td>
</tr>
</tbody>
</table>

* One-way Anova + Chi² tests.

b The mean difference is significant at the level of 0.05.

### 3.2. Tracheostomy data

The patients underwent the tracheostomy average logically in 11.4 ± 4.8 days. There was no significant difference between the groups in terms of the day of the tracheostomy. When the number of punctures was examined, it was determined that 2 or more punctures were applied in 12 patients in group 1, 3 patients in group 2, and 10 patients in group 3 and simultaneously, the success rate of the first entry was similar. In between-groups comparison, these results were statistically significant. Even though the total tracheostomy time (time elapsed between the first needle entry puncture and setting the tracheostomy cannula on the neck) was shorter in group 2 compared to the others, this difference was not significant (P = 0.507). The average tracheostomy time was determined as 7.0 ± 1.4 min (Table 2). No desaturation was observed in any of the patients during the procedure.

Even though complications were seen in a total of 24 patients, 20 of them were local bleedings and they were taken under control via pressurised dressing. Major bleeding was seen in two patients, otracheal intubation was performed and an otorhinolaryngology consultation was requested. While one of the major bleeding cases was observed in the in-plane method, the other one was seen in the traditional landmark method. Subcutaneous emphysema developed in two patients and it was regressed without any intervention. The emphysema occurred during the out-of-plane method in one of the patients and the other occurred using the traditional landmark method. Because no optimal in planeimage could be taken in one patient with BMI = 34, tracheostomy was opened by using the ultrasonography-guided out-of-plane method. The total successful tracheostomy rate was 96.6%.

### 3.3. Between-groups comparisons

When we examined which group caused the statistically significant differences between number of punctures, first entry success and complication rates, we found that the number of punctures was significantly lower in group 2 compared to group 1 and group 3 (P = 0.042). There was no significant difference between group 1 and group 3.

The first entry success was significantly higher in group 2 compared to the other groups (P = 0.003, P = 0.021). No significant difference was found between groups 1 and 3 in terms of first entry success.

When the complications were examined, it was determined that fewer complications were significantly observed in group 2 compared to group 1 (P = 0.025). Even though complications were observed in 12 patients in group 1, 5 patients in group 2 and 7 patients in group 3, no significant difference was observed between groups 1 and 3 (Table 3).

When the other factors affecting the successful first entry in USG-guided tracheostomy were examined independently from the group, it was determined that as age increased, the first entry success significantly decreased (P = 0.013). It was found that sex, body mass index and APACHE II scores did not affect the success rate (Table 4).

When the factors causing the development of complications without making any group discrimination were evaluated, it was determined that age, gender, body mass index and APACHE II scores could not be correlated with the development of complications (Table 5); however, as first entry success increased, number of complications significantly decreased (P = 0.001) (Fig. 1).

In the follow-up of the study 1 month later, 26 patients were still followed up with tracheostomy; 19 patients died; 7 patients were sent to palliative care with a home-type mechanical ventilator and the tracheostomy of 8 patients was closed and they were discharged from hospital. Accidental decannulation developed in three patients and pressure ulcer was seen in one patient.

### 4. Discussion

In this randomised controlled study comparing 3 methods (traditional landmark, ultrasonography-guided out-of-plane and the ultrasonography-guided in-plane method) used in percutaneous tracheostomy, it was determined that the number of punctures in the patients for whom tracheostomy was opened by using the out-of-plane method was less, success at first entry was higher and complication rates were lower.

Routine use of ultrasonography is used to explicitly view the tracheal rings required for the appropriate location of tracheal intervention and to verify the midline placement [6,14–16]. In the review of Alansari et al.; it was specified that the use of ultrasonography reduced the number of entries [11]. In a 23-PDT prospective study of Dinh et al. [10], real-time, long-axis, in-plane USG technique and traditional bronchoscopy landmark technique were compared and the mean number of needle entries was found to be low (1.4 ± 0.7 vs. 2.6 ± 0.9). In a 50-PT randomised controlled study conducted by Rudas et al. [13] to compare the traditional landmark method and the USG-guided out-of-plane application, it was shown that the use of ultrasonography significantly increased the accuracy of puncture and the suitable midline puncture. When comparing with the literature, the number of punctures was found to be significantly lower in USG-guided out-of-plane technique (group 2) than the other two groups in the present study (1.6 ± 0.5 vs. 1.2 ± 0.5 vs. 1.6 ± 0.6). In comparison with the study of Dinh et al. [10], no difference was found between in-plane PDT and the landmark method in terms of number of punctures. This situation is associated with the difficulty of identifying the midline trachea position as the disadvantage of in-plane application [17].

Ultrasonography guidance is argued as a potential tool for increasing the safety and efficiency of the procedure before and during the real-time procedure [6,7]. Sustic [18] reported that the success rate of the first application from the correct tracheal intervention area was between 96 and 100%. The first entry success in USG-guided PT was observed at 87% in the study of Rudas et al. [13], and at 72.7% in the study of Dinh et al. [10]. However, in the study of Dinh et al., tracheal midline was found by using the out-of-plane application before the in-plane application and the probe was then transversely rotated with an angle of 90 degrees and the procedure was completed. Similarly to the literature, the first entry success via USG-guided out-of-plane was found as 85% in the

### Table 3
Between-groups comparisons.

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Group (I)</th>
<th>Group (J)</th>
<th>Mean difference (I-J)</th>
<th>Standard error</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of punctures</td>
<td>1.00</td>
<td>2.00</td>
<td>0.40000^a</td>
<td>0.19240</td>
<td>0.042</td>
</tr>
<tr>
<td></td>
<td>3.00</td>
<td>0.05000</td>
<td>0.19240</td>
<td>0.796</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.00</td>
<td>1.00</td>
<td>−0.40000^a</td>
<td>0.19240</td>
<td>0.042</td>
</tr>
<tr>
<td>First entry success</td>
<td>1.00</td>
<td>3.00</td>
<td>−0.35000</td>
<td>0.19240</td>
<td>0.074</td>
</tr>
<tr>
<td></td>
<td>2.00</td>
<td>0.45000^b</td>
<td>0.003</td>
<td>0.003</td>
<td></td>
</tr>
<tr>
<td>Complication</td>
<td>1.00</td>
<td>3.00</td>
<td>0.10000</td>
<td>0.14720</td>
<td>0.500</td>
</tr>
<tr>
<td></td>
<td>2.00</td>
<td>1.00</td>
<td>−0.45000^a</td>
<td>0.14720</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>3.00</td>
<td>0.35000^a</td>
<td>0.14720</td>
<td>0.500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.00</td>
<td>2.00</td>
<td>−0.35000</td>
<td>0.15160</td>
<td>0.025</td>
</tr>
<tr>
<td></td>
<td>3.00</td>
<td>0.25000</td>
<td>0.15160</td>
<td>0.105</td>
<td></td>
</tr>
</tbody>
</table>

^a The mean difference is significant at the level of 0.05.

### Table 4
Factors affecting first entry success^a.

<table>
<thead>
<tr>
<th></th>
<th>Success</th>
<th>Failure</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (F/M) (n)</td>
<td>12/26</td>
<td>11/11</td>
<td>0.157</td>
</tr>
<tr>
<td>Age (years)</td>
<td>64.32 ± 17.0</td>
<td>74.59 ± 9.8</td>
<td>0.013^b</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>27.21 ± 3.9</td>
<td>29.14 ± 4.7</td>
<td>0.098</td>
</tr>
<tr>
<td>APACHE II</td>
<td>26.253 ± 63</td>
<td>28.591 ± 3.8</td>
<td>0.123</td>
</tr>
</tbody>
</table>

^a Chi² tests.
^b The mean difference is significant at the level of 0.05.

### Table 5
Factors affecting the development of complications^a.

<table>
<thead>
<tr>
<th></th>
<th>Occurred</th>
<th>Non-Occurred</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (F/M) (n)</td>
<td>11/13</td>
<td>12/24</td>
<td>0.329</td>
</tr>
<tr>
<td>Age (years)</td>
<td>71.08 ± 14.0</td>
<td>66.08 ± 16.4</td>
<td>0.226</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>29.00 ± 4.2</td>
<td>27.19 ± 4.3</td>
<td>0.115</td>
</tr>
<tr>
<td>APACHE II</td>
<td>27.438 ± 4.8</td>
<td>26.892 ± 6.1</td>
<td>0.717</td>
</tr>
</tbody>
</table>

^a Chi² tests.
F/M: female/male; BMI: body mass index.

The mean difference is significant at the level of 0.05.

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present study. Again, the lower (50%) success ratio in the in-plane technique was associated with the difficulty in identifying the midline trachea position because we did not use both methods together in this study.

Although the rates of procedure-induced complications were relatively low, serious side effects and even death were reported [4]. Most of these deaths are secondary to PT-induced bleedings, and airway complications are ranked as the second. In the study of McCormick and Manara [5], most of the serious bleedings were associated with unexpected variations that are not recognised in vascular anatomy. In the study of Yavuz et al. [19], it was found that while the rate of perioperative complication was 7.8% in the USG group, this rate was 15% in the control group. Accordingly, Rudas et al. [13] associated the use of USG with fewer complications. In the present study, the complication rate was significantly lower in both USG groups. This was due to making the procedure safer by showing abnormal vessels in the puncture area of the pre-procедural imaging.

As specified by Alansari et al., ultrasonic imaging of the upper airway tract provides important anatomic information, especially about the anatomy of the pretracheal and paratracheal areas. In this review, it was specified that the use of ultrasonography while opening the PT increased the rate of the PT [11]. Chacko et al. [8] used ultrasonography to determine the location of the tracheal intervention and specified that the mean entry time of the guide wire was 12 s, and the total operation time was 12 minutes. Similarly, Süstic et al. [20] determined the application time of USG-guided PT to be 8 minutes. Also, mean tracheostomy time was determined to be 7.0 ± 1.4 min in the present study. Even though it was completed in a shorter period via the out-of-plane application, this difference was not statistically significant (7.3 min ± 1.3 vs. 6.7 min ± 1.3 vs. 7.1 min ± 1.5). This was due to the fact that the ultrasonography rapidly identified the correct tracheal position and shortened the total tracheostomy time.

When the factors affecting the first entry success were examined in the present study, it was observed that an advanced age significantly decreased the success rate. It was thought that it was associated with difficulties in positioning due to age-related disorders in the musculoskeletal system.

When examining the factors affecting the development of complications in the present study, it was observed that a first entry success was correlated with the development of complications. As the first entry success increased, the complication rate also decreased. This may be associated with the increasing number of injured vessels and tissues and with the increasing number of punctures.

5. Limitations

First, as there was no flexible bronchoscopy in our hospital, we determined the first entry success in the traditional landmark method by the air/water aspiration from the injector. Second, the number of patients was low because it was a single-centred study. Third, it may be difficult and subjective to define some complications such as “minor bleeding” that do not require intervention. Complications should be clearly defined. Fourth, due to the small non-significant difference between BMI, the safety or effectiveness of ultrasonography in morbidly obese patients cannot be proven. Morbid obesity should be investigated.

We think that percutaneous tracheostomy, especially USG-guided out-of-plane application, would increase the success rate, decrease the number of punctures and reduce complications due to its midline determination success; it can also be used safely in patients with difficulty in giving longitudinal position, tracheal deviation and also in short-neck patients. Although the short-axis out-of-plane approach seems to be superior to the other methods, we think that it is necessary to perform the procedure after a long-axis imaging check. USG is a dynamic exam and should be used in every condition to reduce morbidity.

6. Conclusion

In this randomised controlled study comparing landmark, USG-guided out-of-plane PT and USG-guided in-plane PT methods, it was determined that USG-guided out-of-plane application had a lower number of punctures, a higher first entry success rate and a lower complication rate. It was observed that advanced age negatively affected the first entry success and as the number of punctures increased, the complication rate also increased.

Disclosure of interest

The authors declare that they have no competing interest.

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