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1 **TYPE OF ARTICLE:** Case Report

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3 **TITLE:** Intraoral kinking of an endotracheal tube during position change in a patient
4 with tracheal deviation

5

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35 **Short Running Title:** Tube kinking with tracheal deviation

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37 **Guarantor of Submission:** The corresponding author is the guarantor of
38 submission.

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EARLY VIEW

65 **ABSTRACT**

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67 **Introduction**

68 Maintenance of ventilation through the endotracheal tube during surgery is essential,
69 and failure to do so can cause serious consequences.

70

71 **Case Report**

72 We experienced a case of intraoral kinking of the polyvinyl chloride, single-lumen
73 endotracheal tube (ETT) in a patient with severe tracheal deviation caused by
74 pulmonary tuberculosis. During surgery, the operation table was tilted upward and to
75 the left, which caused change in patient's head position and led to intraoral kinking.

76

77 **Conclusion**

78 If there is a severe tracheal deviation expected to cause deformity of the ETT, it is
79 recommended to use a reinforced tube.

80

81 **Keywords:** Anesthesia complication, Kinking of endotracheal tube, Temperature,
82 Tracheal deviation.

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97 **INTRODUCTION**

98 Securing and maintaining a passage from anesthesia machine to a patient's
99 respiratory tract is a basic element for the safety of the patient. Ventilatory failure
100 caused by airway obstruction during surgery may result in serious complications
101 such as brain damage, and must be detected and resolved early. Airway obstruction
102 can be caused by factors such as closure of the breathing circuit, existence of a
103 foreign body in the tube, or kinking of the tube [1]. Kinking of the endotracheal tube
104 can be caused by improper positioning of the patient during surgery [2-4] and
105 thermal softening of tube [5,6].

106 We report a case of a patient with a severe tracheal deviation who underwent
107 insertion of a polyvinyl chloride (PVC), single-lumen endotracheal tube (ETT) and
108 experienced intraoral kinking after a change in position.

109

110 **CASE REPORT**

111 A 76-year-old woman with a height of 150 cm and a weight of 41 kg was scheduled
112 to undergo laparoscopic cholecystectomy under the diagnosis of chronic
113 cholecystitis. She has been diagnosed with pulmonary tuberculosis 11 years prior.
114 Preoperative laboratory results showed no specific findings, the chest x-ray revealed
115 a destruction of the right lung with tracheal deviation (Figure 1), and pulmonary
116 function test (PFT) result showed a small airway obstructive lung defect.

117 General anesthesia was induced with injection of propofol intravenously and infusion
118 of remifentanyl. Rocuronium was used as a muscle relaxant, followed by intubation
119 with a conventional PVC, single-lumen ETT (Hi-Lo Oral / Nasal tracheal tube cuffed,
120 COVIDIEN™ Mallinckrodt™, Ireland, ID 6.5 mm). Although there was slight
121 resistance during intubation, auscultation confirmed clear lung sounds in both lungs,
122 and the ETT was fixed at a depth of 22 cm from the incisor. Anesthesia was
123 maintained with 4 - 5% desflurane and remifentanyl infusion of 0.08 - 0.125
124 mcg/kg/min. The ventilator settings were as follows: tidal volume 260 ml, respiratory
125 rate 12 per min, positive end-expiratory pressure 5 cmH₂O, and fraction of inspired
126 oxygen concentration 0.5. Esophageal temperature was 36.0 °C..

127 Eight minutes into surgery, the position of the patient was changed from supine to
128 reverse-Trendelenburg with a slight tilt to the left. Suddenly, monitoring alarm for

129 airway pressure was activated with an increase in peak airway pressure from 19
130 cmH₂O to 35 cmH₂O and a decrease in tidal volume to 50 ml. End-tidal CO₂
131 monitoring first showed obstructive pattern followed by a sudden fall in the value to
132 10 mmHg, and then was not detected at all. The ventilator setting was converted to
133 manual ventilation, but tidal volume could not be attained. There were no signs of
134 tube blockage outside of the mouth or damage to the circuit. Breathing circuit and
135 extraoral portion of the tube were checked with no signs of obstruction or kinking.
136 The patient's head was noted to be slightly flexed, so we extended it, which
137 improved tidal volume to 200 ml with a respiratory rate of 20 per minute and allowed
138 measurement of end-tidal CO₂ partial pressure, at 60 mmHg. One minute later,
139 however, the airway pressure increased again, and sufficient tidal volume was not
140 maintained. Manual ventilation was attempted again; there was no improvement and
141 obstruction was observed. We attempted to insert a suction catheter into the tube,
142 but it would not pass beyond the tube midline.
143 Using a laryngoscope, we examined the oral cavity and found that the ETT was bent
144 at the anterior part of the epiglottis (Figure 2). A request was made to stop the
145 surgery, and re-intubation using a reinforced ETT (Lo-Contour Oral / Nasal tracheal
146 tube cuffed, COVIDIAN™ Mallinckrodt™, Ireland, ID 6.5 mm) was performed. After
147 tube exchange, surgery was resumed, and there were no other unusual events
148 through the end of the operation.

149

150 DISCUSSION

151 Sezkely et al. reported that, in an analysis of ETT problems, endobronchial
152 intubation was the most common, followed by obstruction and kinking, esophageal
153 intubation, disconnection, leakage, and cuff hernia [1]. Kinking of the ETT occurs
154 mainly outside of the mouth, with occurrence in the intraoral portion rarely reported
155 [1,5,7,8].

156 Partial or complete kinking of the tube can occur depending on the vector direction of
157 the force applied to the fixed tube in the intraoral region, which is mostly affected by
158 patient positioning [2-4,9]. Prone positioning during posterior fossa surgery with neck
159 flexion may cause tube kinking [2], particularly when the atlanto-axial joint is
160 maximally flexed [4]. It has been reported that even in supine position, intraoral tube

161 kinking occurred thirty minutes after intubation, causing ventilation impossible.
162 Although tube patency was maintained, increase in the tube temperature caused
163 softening of the tube eventually causing kinking [6]. Occurrence of kinking might
164 increase with vector of forces according to position and thermal softening of the tube.
165 In care of patients, it is important to anticipate complications and use preventive
166 measures to prevent the risk of kinking. There are reasons why we used single
167 lumen tube instead of reinforced tube. After evaluating patient's chest X-ray for
168 tracheal deviation, it seemed that use of single lumen tube would not be a problem.
169 Also, our nation provides all citizens with NHI (National Health Insurance). NHI
170 controls all aspects of medical services, including medical supplies. According to NHI
171 guideline, reinforced tube is not indicated in our case, limiting its use.
172 In this case, we believe that three factors were involved in the kinking of the ETT.
173 First, the patient's right lung was destroyed by pulmonary tuberculosis, and the
174 airway was severely deviated to the right. It is possible that an abnormal force was
175 applied to the right side of the PVC tube due to this deviation. Second, the patient
176 was small in stature, and the pillow might have been relatively high, causing severe
177 flexion. Also, at the beginning of the surgery, the operation table was tilted upward,
178 which might have applied further force that led to kinking of the tube. Finally, if the
179 oral temperature rises above 36 °C, the PVC of the tube can soften and increase the
180 risk of bending [6]. In this case, the body temperature during the operation was 36
181 °C.

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183

184 **CONCLUSION**

185 Factors such as anatomical variation (e.g. tracheal deviation), position change during
186 surgery, and thermal softening of the tube may act singly or in combination to cause
187 endotracheal tube kinking. If the patient is in high risk, we strongly recommend using
188 reinforced tube.

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190 **CONFLICT OF INTEREST**

191 Authors declare no conflict of interest.

192

193 **AUTHOR'S CONTRIBUTIONS**

194 Jihyoung Park

195 Group1 - Conception and design, Acquisition of data, Analysis and interpretation of
196 data

197 Group 2 - Drafting the article, Critical revision of the article

198 Group 3 - Final approval of the version to be published

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200 Kwang Ho Lee

201 Group1 - Conception and design

202 Group 2 - Critical revision of the article

203 Group 3 - Final approval of the version to be published

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205 Wikwang Wang

206 Group1 - Conception and design, Acquisition of data, Analysis and interpretation of
207 data

208 Group 2 - Drafting the article

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221 Group1 - Conception and design, Acquisition of data, Analysis and interpretation of
222 data

223 Group 2 - Drafting the article, Critical revision of the article

224 Group 3 - Final approval of the version to be published

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249 withdrawal maneuver of the Pentax-AWS Airway Scope. *Masui* 2013;
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251

252 **FIGURE LEGENDS**

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254 Figure 1: Chest PA shows a destruction of the right lung with severe tracheal
255 deviation.

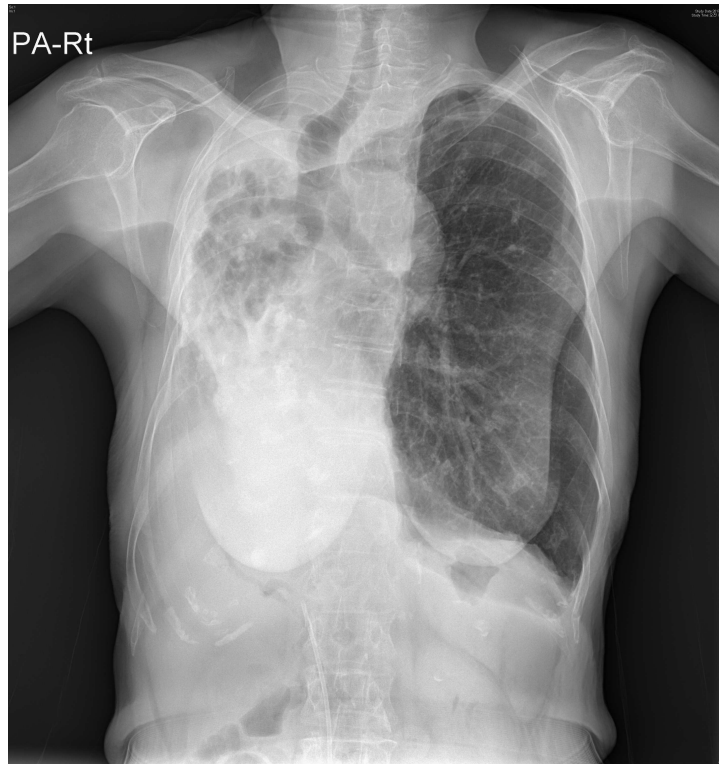
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257 Figure 2: Endotracheal tube (ETT) removed from the patient: (A) - Kinked ETT
258 (arrow); (B) - Kinked in an unusual direction (arrow head).

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260 **FIGURES**

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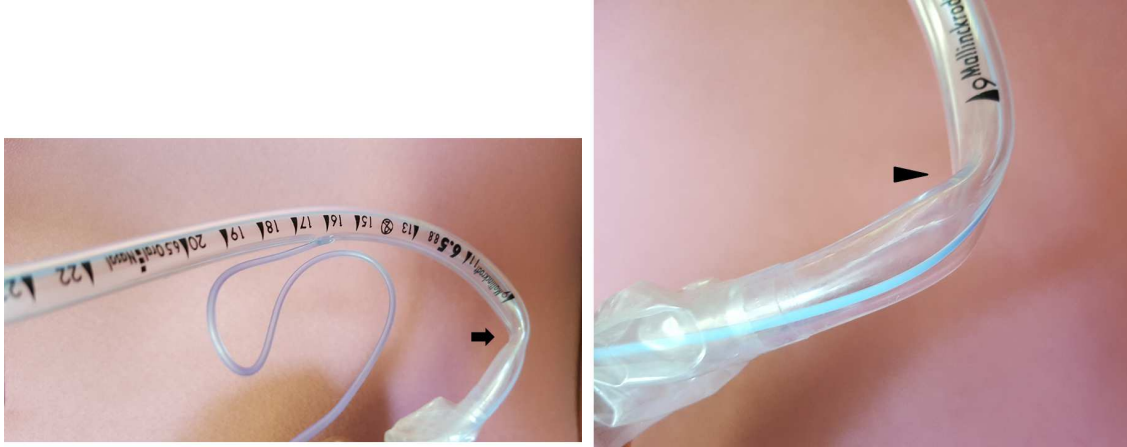
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EARLY VIEW