

First-aid Fast Track Channel in Rescuing Critically Ill Children With Airway Foreign Body: Our Clinical Experience

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First-aid Fast Track channel in rescuing critically ill children with airway foreign body: our clinical experience

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Abstract:

Objective To explore the role of First-aid Fast Track channel in rescuing children with airway

foreign body, and to analyze and summarize the experience and lessons of First-aid Fast Track

channel in rescuing airway foreign body in critical condition.

Methods Clinical data of 21 cases of First-aid Fast Track channel rescue admitted to our hospital

from January 2017 to December 2020 were retrospectively collected, including 12 males and 9

females, aged 9-18 months, with an average age of 15 months and a history of 1-72 hours. Follow-

up medical history showed that all 21 children had a history of significant foreign body cough.

Results 21 cases of airway foreign body were successfully removed without second operation.

Twenty-one critically ill children were intubated into PICU after surgery. Two of the children had

a history of asphyxia rescue in a foreign hospital. After endotracheal intubation and

cardiopulmonary resuscitation, the ambulance was sent to our hospital. Although the foreign body

22 was removed, the patient's family gave up the treatment because the brain hypoxia lasted too long
23 and the deep coma could not be recovered.

24 **Conclusion** First-aid Fast Track channel of airway foreign body is the cooperation of
25 otolaryngology, anesthesiology, ICU, emergency room and other departments, which has won
26 valuable time for rescue, highlighted the purpose of rescue, improved the success rate of rescue
27 and the quality of life of children, and is of great value for the treatment of critical tracheal foreign
28 body.

29 **Abbreviation:** ICU= intensive care unit.

30 **Key words:** First-aid Fast Track channel, Foreign Bodies, Trachea, Child.

31 **Declarations:**

32 **Ethics approval, guidelines and consent to participate** All procedures performed in this study
33 involving human participants were in accordance with the ethical standards of the institutional and
34 national research committee and with the 1964 Declaration of Helsinki and its later amendments
35 or comparable ethical standards. The study was approved by the ethics committee of the Shenzhen
36 Children's Hospital. Due to all participants included in the study are under 18, informed consent
37 was obtained from all individual participants' parents and/or legal guardian.

38 **Consent for publication** Informed consent for publication was obtained from all patients' parents
39 for the use of their medical records and CT images in writing this study. All the authors have
40 approved the manuscript and agree with submission to your esteemed journal.

41 **Availability of data and materials** The datasets used and/or analysed during the current study are
42 available from the corresponding author (YS.T, tys118@163.com) on reasonable request.

43 **Conflicts of interests** All authors declare that they have no conflict of interest.

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45 Committee (no. JCYJ20170303155115313). None of the sponsors were involved in the study
46 design; collection, analysis and interpretation of data; writing of the manuscript; and the decision
47 to submit the manuscript for publication.

48 **Authors' contributions** Y.C.C, Y.S.T and Z.X. X contributed to the study conception and design;
49 data acquisition, analysis, and interpretation; and drafting and critical revision of the manuscript.
50 S.H.H contributed to the study conception and design; data analysis and interpretation; and critical
51 revision of the manuscript. L.L contributed to the study design and data interpretation and
52 critically revised the manuscript. All authors provided final approval and agree to be accountable
53 for all aspects of the work.

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60 **1 Introduction**

61 As a worldwide health problem, airway foreign body is a commonly encountered emergency
62 in Department of Otolaryngology, especially in Pediatric Otolaryngology[1]. About 80% of all
63 foreign body aspirations occur in children, especially in infants below 3 years of age. Improper
64 handling may result in a high mortality rate, and its degrees of severity depend primarily on the
65 nature, location and blockage of foreign bodies. Common complications related to airway foreign

66 body include recurrent pneumonia, emphysema, atelectasis, bronchiectasis, and even death[2].
67 Delayed surgical treatment may induce severe complications, such as irreversible lung injury, brain
68 injury and even death[3-6]. Consequently, timely and accurate diagnosis and treatment are of great
69 significance particularly for the prevention of complications, especially for children with airway
70 foreign bodies in critical conditions. Our hospital has established First-aid Fast Track for children
71 with airway foreign bodies in critical condition. The First-aid Fast Track is composed of
72 Otolaryngology, Anesthesiology, intensive care unit (ICU), Emergency Rescue and other
73 departments. As for the First-aid Fast Track, the first-consulting otolaryngologist may check the
74 child and then determine the condition of the child according to the medical history, clinical
75 symptoms and/or auxiliary examinations, such as neck and chest CT. If the child is in critical
76 condition, the otolaryngologist may immediately call the Operating Room to start the First-aid Fast
77 Track. The child will be escorted to the Operating Room by the first-consulting otolaryngologist
78 together with the anesthesiologist and nurse in the Operating Room on call. The bronchoscopy and
79 subsequent foreign body removal operation will be performed as soon as possible in the next step.

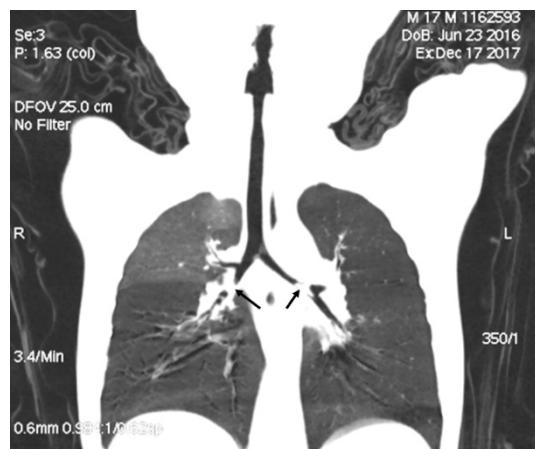
80 A retrospective analysis was carried out in this study by collecting the clinical data of 21 cases
81 underwent rescue through the First-aid Fast Track in our hospital from January 2017 to December
82 2020. Our study analyzed and summarized comprehensively the experience and lesson of First-aid
83 Fast Track in rescuing children with airway foreign bodies in critical condition. The present study
84 is expected to provide potential reference for future diagnosis and treatment, especially for the
85 screening of children with airway foreign bodies in critical condition. It is reported as follows.

86 **2 Data and Methods**

87 **2.1 General data**

88 The objects of study were 21 children with airway foreign bodies in critical condition in our
89 hospital from January 2017 to December 2020. Of the enrolled 21 cases, there were 12 boys and 9
90 girls, ranging from 9 months to 18 months, with a mean age of 15 months of age and an illness
91 duration of 1 hour to 72 hours. As for the location of foreign bodies, 5 cases had glottic foreign
92 bodies, 10 cases had tracheal foreign bodies, 6 cases had bilateral bronchial foreign bodies. In terms
93 of the species of foreign bodies, 4 cases were bone and 1 case was plastic in the 5 cases of glottic
94 foreign bodies, while 1 was apple, 8 peanut, 4 melon seeds and 3 pistachios among the other 16
95 cases (Figure1,2,3,4, Table 1). Medical history inquiry indicated that all the 21 children had obvious
96 history of foreign body cough. Furthermore, concerning the clinical symptoms, 15 children
97 developed degree III inspiratory dyspnea, 4 children had mixed dyspnea, 2 children had received
98 tracheal intubation and balloon assisted respiration in other hospital, 3 children had mental
99 depression, blurred or lost consciousness, pale face, irregular heart rate as well as thready and rapid
100 pulse (Table 1). There were 3 cases of glottic foreign bodies based on preoperative electronic
101 laryngoscope view results, 9 cases of tracheal foreign bodies suggested by CT examination, and 9
102 cases of children without preoperative examination (Table 1). According to the medical history,
103 clinical symptoms, physical signs and/or auxiliary examinations, the first-consulting
104 otolaryngologist ordered the First-aid Fast Track for the 21 children. After calling the Operating
105 Room and the superior doctor, the first-consulting otolaryngologist provided children with oxygen
106 inhalation and delivered these pediatric patients to the Operating Room immediately. After arrival,
107 the anesthesiologist immediately gave the mask oxygen inhalation or connected the anesthesia
108 ventilator. While the circulating nurse opened the intravenous line, and monitored the respiration,
109 heart rate, blood oxygen saturation and ECG of the children.

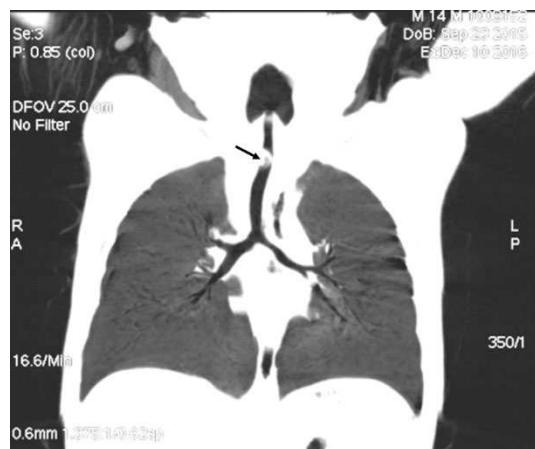
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111

Figure 1 Bilateral Bronchial foreign body (peanut)

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113

Figure 2 Endotracheal foreign body (peanut)

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115

Figure 3 Endotracheal foreign body (sunflower seeds)

116



117

Figure 4 Foreign body in glottis (fishbone)

Table 1 Characteristic of First-aid Fast Track channel in rescuing children with airway foreign body

Characteristic	Number	Percent (%)
1. Gender		
boys	12	57.1
girls	9	42.9
2. Age (months)		
< 12	4	19.0
12-15	7	33.33
15-18	10	47.62
>18	0	0
3. Clinical symptoms		
Cough	21	100.0
III inspiratory dyspnea	15	71.4
Mixed dyspnea	4	19.0
Assisted respiration	2	9.5
Hypoxia symptoms [#]	3	14.3
4. Preoperative examination of foreign bodies found		
Electronic laryngoscope	3	14.3
CT	9	42.9
Without preoperative examination	9	42.9
5. The location of foreign bodies		
Glottic foreign bodies	5	23.8
Tracheal foreign bodies	10	47.6
Bilateral bronchial foreign bodies	6	28.6
6. The species of foreign bodies		
Bone	4	19.0
Plastic	1	4.8
Apple	1	4.8
Peanut	8	38.1
Melon seeds	4	19.0

#mental depression, blurred or lost consciousness, pale face, irregular heart rate, thready and rapid pulse.

118 **2.2 Rescue and treatment**

119 Hard bronchoscopy was the first choice for foreign body in trachea[7]. All the patients were
120 operated under intravenous combined general anesthesia. Children were adjusted to the head tilted
121 back, the laryngoscope was placed to expose the glottis, followed by the placement of rigid STORZ
122 bronchoscope of appropriate size. Attention was paid to the observation and aspiration of the
123 secretion when entering the laryngoscope, and the foreign body was taken out eventually.
124 Meanwhile, attention was also paid to, the size and shape of the foreign body intraoperatively, and
125 the appropriate foreign body forceps was selected accordingly. No tracheotomy was performed in
126 all the children.

127 **3 Analysis of typical cases**

128 **Case 1** A female pediatric patient of 16 months old was admitted to the hospital due to "6 hours
129 after asphyxia and 2 hours after cardiopulmonary resuscitation". Six hours ago, the child developed
130 cough, cyanosis, dysphoria and crying after eating pistachios, with slight three-concave sign. About
131 5 minutes later, the family members sent the child to the nearest hospital, with the blood oxygen
132 saturation measured to be about 93%, and the child was provided with oxygen inhalation and
133 sedation. Emergency chest X-ray examination showed that the transmittance of both lungs was the
134 same, and there was no mediastinal shift. Two hours ago, the blood oxygen saturation of the pediatric
135 patient could not be maintained, the heart rate gradually slowed down to 20 times/min, the pupil
136 dilated to 5-6mm, and the pupillary reaction to light was absent. The child was given tracheal
137 intubation and chest compression, combined with epinephrine, atropine Intravenous injection,

138 sodium bicarbonate for the regulation of acid-base balance and other treatment. There was many
139 bloody sputum in tracheal tube. About 20 minutes later, the child's heart rate recovered 160
140 times/min, the blood oxygen saturation was about 97%, and the pupil diameter was 2.5mm. The
141 patient was still in critical condition after intravenous injection of furosemide, mannitol for
142 Intracranial decompression and intravenous infusion of methylprednisolone. For further diagnosis
143 and treatment, the child was transferred to our hospital by 120 ambulance. The child was transported
144 to the Emergency Room of our hospital in the state of tracheal intubation, with heart rate of 160
145 times/min, blood oxygen of 95%, weak and symmetrical lung respiratory murmur by auscultation
146 of both lungs, moist rales in both lungs, and with the aspiration of many red foam-like secretions in
147 the endotracheal tube. The possibility of airway foreign bodies was considered in accordance with
148 the medical history of the child and the results of physical examination. The doctor informed the
149 parents of the critical condition of the child, and explained the presence of indications for surgical
150 exploration. A First-aid Fast Track was established after obtaining informed consent of parents.
151 Following tracheal extubation, the rigid bronchoscope was placed during operation, with the
152 discovery of more red foam-like secretions in the lungs and two drops in the blood oxygen to 60%.
153 After that, the operation was stopped with the bronchoscope withdrawn to the main airway was
154 retreated. The side hole of rigid bronchoscope was used for anesthesia to assist ventilation. The
155 blood oxygen of the patient was increased to over 90%, and the bilateral bronchi were explored
156 continuously. During the operation, 3 pistachios were taken out on the right side and a piece of
157 pistachio shell was taken out from the left lung. There was no significant intraoperative decrease in
158 heart rate, and the patient was monitored in PICU with tracheal intubation. After operation, the
159 patient was in deep coma, with no spontaneous breathing triggering, no cough reflex, and with great

160 fluctuation in blood oxygen. Brain CT showed diffuse brain edema and the space around brain stem
161 disappeared. The patient was in a state of continuous deep coma, with no response to pain
162 stimulation, unequal size of bilateral pupils, disappearance of pupillary reaction to light, no trigger
163 of spontaneous respiration, and no cough reflex. After careful consideration, the family members
164 gave up the treatment.

165 **Case 2** A male patient of 18 months old was admitted to the hospital due to "cough with panting
166 for 2 hours after eating peanuts". Two hours ago, the child had severe cough due to a fall when
167 eating peanuts, with wheezing and no cyanosis, with symptoms improved two minutes later. The
168 parents took the child to our hospital for medical examination, with ruddy face, no cyanosis of lips
169 and three-concave sign, breaths rate of 35 times/min, heart rate of 120 times/min, thick breath
170 sounds in both lungs, slightly weak on the right side, and with few wheezes. The doctor in the
171 Outpatient Department told the parents of a great possibility of foreign body in the right bronchus,
172 and informed the risk and precautions of airway foreign body. The parents signed for confirmation.
173 In order to make a definite diagnosis, CT of neck and chest was made for the patient, and sedative
174 chloral hydrate was prescribed for enema. One hour later, the child was delivered to the Outpatient
175 Department from the Radiology Department. The parents reported that the child had poor spirit,
176 failed to complete CT examination, and vomited during enema. Physical examination: Mental
177 depression, vague consciousness, pale face, shallow and frequent breathing pattern, no obvious
178 three-concave sign, weak breath sound on both sides, few wheezes, and blood oxygen monitored to
179 be 75%. The possibility of foreign bodies in bilateral bronchus was considered and a First-aid Fast
180 Track was established urgently. When the laryngoscopy was used to expose glottis under anesthesia,
181 it was found that there was gastric juice like mucus and several pieces of broken peanut in throat.

182 After the placement of rigid bronchoscope, it was discovered that the gastric mucus was found in
183 the trachea, and several pieces of peanuts were blocked in the bronchi of both sides. The operation
184 was successful. After the operation, the patient was transferred into PICU with tracheal intubation
185 for monitoring. The patient recovered normally and discharged from the hospital.

186 **Case 3** A male pediatric patient of 10 months old was admitted to the hospital due to "cough
187 with panting for 6 hours after eating apple". Six hours ago, the child had a severe cough,
188 accompanied by panting and pale face, with cough improved three minutes later, but still with
189 panting. The parents took the child to our hospital for medical examination, with ruddy face, no
190 cyanosis of lips, mild three-concave sign, breaths rate of 38 times/min, heart rate of 135 times/min,
191 thick and slightly weak breath sound in both lungs, and obvious wheezes. The possibility of foreign
192 bodies in the trachea were considered according to the medical history and physical examination
193 results, and then the patient was escorted to the Inpatient Ward. In the process of preoperative
194 examination, the patient cried during the blood drawing in the Treatment Room, with sudden
195 asphyxia and face cyanosis. Emergency tracheal intubation was carried out with balloon-assisted
196 respiration, and the face of the patient returned to normal. The establishment of a First-aid Fast
197 Track, more secretions was found in the trachea during the operation, and apple blocks were
198 observed above the trachea eminence after inhalation. After the foreign body was removed, the child
199 was transferred into PICU with tracheal intubation for monitoring. The patient recovered normally
200 and discharged from the hospital.

201 4 **Discussion**

202 Airway foreign body is a common emergency in Pediatric Otorhinolaryngology practice,
203 which is one of the main causes of children's accidental death. Zhang Yamei et al [8]reported that

204 the perioperative mortality rate was 1.28% in children with airway foreign bodies. Early diagnosis
205 and prompt surgical treatment can effectively reduce the mortality rate. Airway foreign bodies are
206 divided into critical cases, severe cases and common cases. Once confirmed and suspected, children
207 with airway foreign bodies in critical condition need to be explored to take the foreign body out as
208 soon as possible. The top priority is to ensure the life safety of children. In this paper, a retrospective
209 review was carried out focusing on the clinical data of 21 cases with airway foreign bodies received
210 treatment on the basis of the establishment of First-aid Fast Track in our Department in the past 4
211 years. It is expected to summarize the experience and lessons for further guidance.

212 There was no missed diagnosis in the enrolled 21 cases, and the parents provided a clear
213 medical history of foreign body inhalation. Detailed medical history collection is particularly
214 important, both missed diagnosis and misdiagnosis will cause harm to children, or even death. The
215 visit time of the 21 children was short ranging from 1 hour to 72 hours, which was related to the
216 obvious symptoms of these children with serious illness. Of the 21 children, 10 cases of trachea
217 foreign body and 6 cases of bilateral bronchus foreign body were treated within 1-6 hours. Among
218 the 5 children with glottic foreign bodies, 2 cases were treated 48 hours later, which may be related
219 to the initial symptoms of hoarseness and laryngeal stridor caused by glottic foreign bodies, and the
220 asymptotic aggravation of dyspnea.

221 The first-consulting doctor plays an important role in judge children in critical conditions. For
222 children with degree III and above inspiratory dyspnea, there is no difficulty in diagnosis in
223 accordance with medical history and/or auxiliary examination, and First-aid Fast Track can be
224 quickly opened for rescue. However, enough attention should be paid to the foreign bodies in
225 bilateral bronchus. The mortality rate of bilateral foreign bodies in bronchus was 2% - 3%, most of

226 which could not be rescued in time, and some of which were caused by improper operation or
227 postoperative complications[9]. In this case, dyspnea is commonly mixed type, without obvious
228 manifestation of inspiratory dyspnea, which is easy to cause false impression. Meanwhile, asphyxia
229 can occur immediately if bilateral bronchi are blocked seriously. During physical examination, there
230 is a need to not only compare the strength of breath sounds in both lungs, but also pay attention to
231 whether there is a reduction in the breath sounds bilaterally. Patients with the same degree of
232 bilateral blockage may develop emphysema or have the same transmittance of both lungs [10]. In
233 Case 1 and Case 2 reported in this study, the postoperative diagnosis was bilateral foreign body in
234 bronchus, with mixed three-concave sign, which was mixed dyspnea, and the appearance of low
235 breath sounds in auscultation of both lungs. In chest X-ray film of Case 1, the transmittance of both
236 lungs was the same, and there was no mediastinal shift. Besides, the successful rescue of Case 2
237 suggested that rapid and effective treatment can avoid serious complications and even death. It is of
238 great significant for the first-consulting doctor to judge the patient's condition. In the case of severe
239 conditions, the First-aid Fast Track should be opened immediately for rapid and effective treatment
240 to avoid serious complications.

241 In terms of the influence of the type of foreign body on the disease, there are many types of
242 foreign bodies in children's airway, including plants, animals, mineral compounds, etc., particularly
243 plant species, such as peanuts, melon seeds, etc. In general, the free fatty acids of plants may produce
244 great stimulation to the airway, leading to mucosal congestion and swelling, and increased secretion,
245 aggravating airway obstruction and worsened dyspnea, and thus increasing the difficulty of
246 operation[11, 12]. Cases 1, 2 and 3 were all vegetable foreign bodies, which stimulated the airway
247 greatly. Despite a short inhalation duration of the foreign body, there were more secretions in the

248 airway during the operation, which accelerated the development of the disease. Furthermore, among
249 the 5 cases of glottic foreign bodies, bone and plastic pieces produced a larger physical stimulation
250 to airway rather than direct chemical stimulation.

251 Concerning the necessity of imaging examination, the detection rate of MSCT for tracheal
252 foreign bodies in children is significantly higher than that of X-ray examination, and the former
253 approach can clearly show the position, shape and size of foreign bodies. Therefore, computed
254 tomography displays a superiority in pediatric tracheal examination[13]. Both chest X-ray and chest
255 fluoroscopy can show the presence and location of foreign bodies[14]. However, children need to
256 be in a quiet state during CT examination. For children who can't sleep, chloral hydrate (0.5ml/kg)
257 should be given for sedation, which is thus not suitable for children with obvious dyspnea.
258 Meanwhile, when children cough or move violently during chloral hydrate sedation, the foreign
259 body may also be changed in position or from unilaterally to bilaterally, resulting in the aggravation
260 of dyspnea. In Case 2, gastric juice like mucus and several pieces of broken peanuts were found in
261 the throat when the glottis was exposed by using laryngoscope under anesthesia, with the detection
262 of gastric juice like mucus in the trachea through rigid bronchoscope. The patient cried during
263 sedation by the enema of chloral hydrate, resulting in the aspiration after vomiting that aggravated
264 dyspnea. In this regard, it was necessary to judge the condition of the child based on the medical
265 history, symptoms and signs of foreign body inhalation, and it was determined that imaging
266 examination was unnecessary. Moreover, the parents of the child shall be informed to pay close
267 attention to the breathing, complexion and mental state during the period of waiting for examination
268 and should not leave the hospital.

269 The First-aid Fast Track for the treatment of airway foreign body is the cooperation of

270 Otolaryngology, Anesthesiology, ICU, Emergency Room and other departments, reflecting the
271 overall rescue ability of the hospital. The establishment of First-aid Fast Track in children with
272 airway foreign bodies in critical condition saves precious time for rescue, highlights the purpose of
273 rescue, improves the success rate of rescue and the quality of life of children. It is of great
274 significance for the treatment of pediatric airway foreign bodies in critical condition.

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278 **Authors' contributions**

279 YC.C, YS.T and ZX. X contributed to the study conception and design; data acquisition, analysis,
280 and interpretation; and drafting and critical revision of the manuscript. SH.H contributed to the
281 study conception and design; data analysis and interpretation; and critical revision of the
282 manuscript. L.L contributed to the study design and data interpretation and critically revised the
283 manuscript. All authors provided final approval and agree to be accountable for all aspects of the
284 work.

285 **Conflicts of interest**

286 All authors declare that they have no conflict of interest.

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Figures

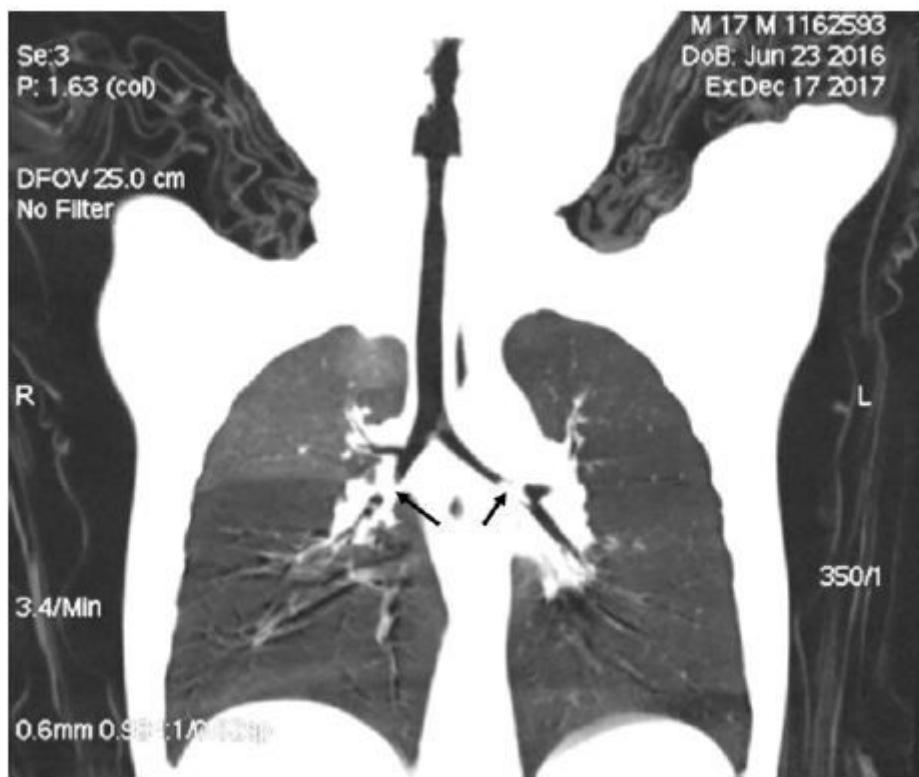


Figure 1

Bilateral Bronchial foreign body (peanut)

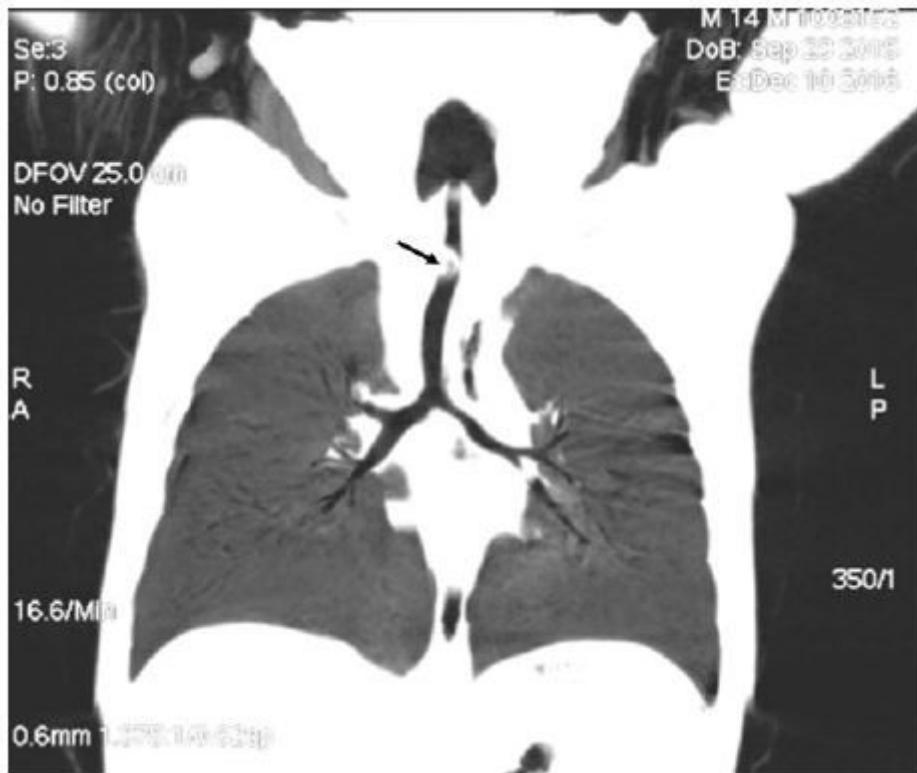


Figure 2

Endotracheal foreign body\peanut\

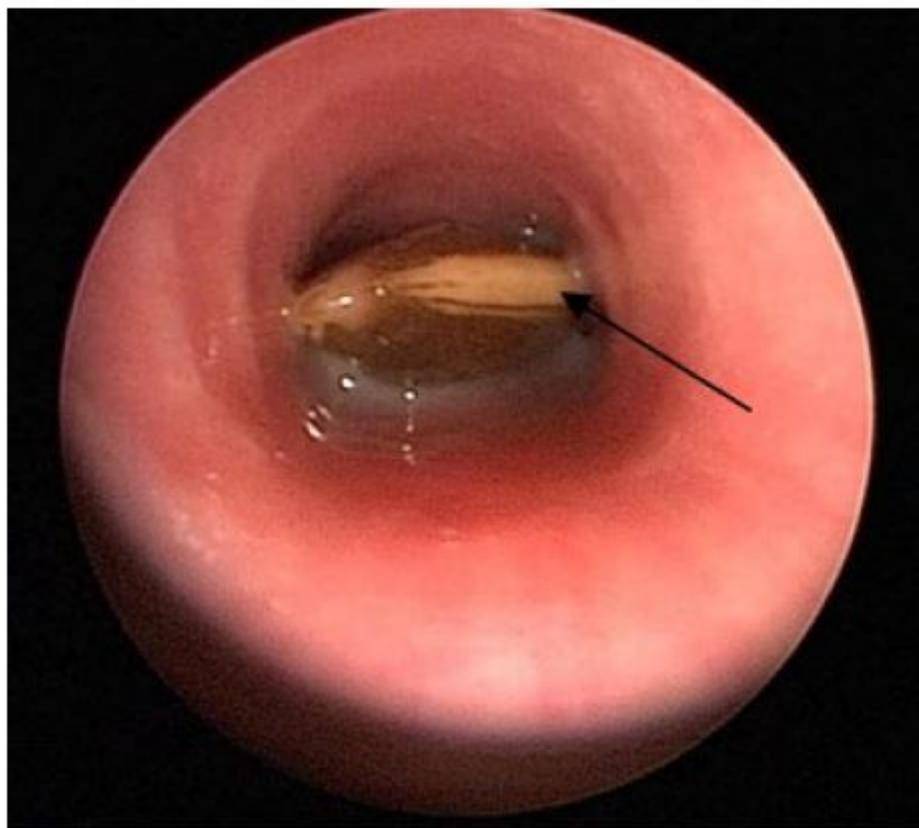


Figure 3

Endotracheal foreign body\sunflower seeds\

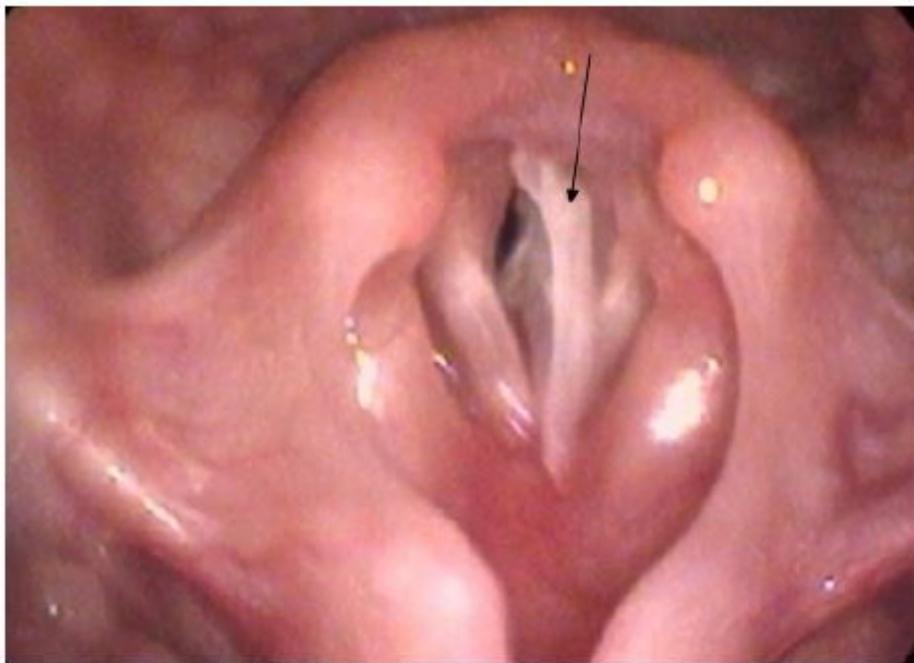


Figure 4

Foreign body in glottis (fishbone)