Original Article

Accuracy of Lateral Neck Radiography in Diagnosis of Foreign Body Ingestion

Chanticha Chotigavanich MD[1], Ranista Tongdee MD[2], Petcharat Aeimpongpaiboon MD[1], Cheerasook Chongkolwatana MD[1]

[1] Department of Otorhinolaryngology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand
[2] Department of Radiology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand

Objective: To determine the accuracy of plain lateral neck radiograph in diagnosis of foreign body [FB] in oropharynx, hypopharynx, and cervical esophagus.

Materials and Methods: A prospective study was done on 57 patients presented with suspicion of FB ingestion. Plain lateral neck radiography was done in all patients. The patients received complete ENT examination of oral cavity and pharynx and FB was removed under local anesthesia if the FB was found. If the FB could not be found in oral cavity or pharynx and the patients still had symptoms suspicious of FB impaction or FB in esophagus or presence of radiographic finding of FB, direct laryngoscopy and/or rigid esophagoscopy under general anesthesia would be done to determine the presence of FB in hypopharynx or cervical esophagus.

Results: FB was found in 47 out of 57 patients, 23/47 (48.9%) at oropharynx, 9/47 (19.1%) at hypopharynx, and 15/47 (31.9%) at cervical esophagus. Overall sensitivity and specificity of plain lateral neck radiography to diagnose FB at oropharynx and hypopharynx or cervical esophagus was 44.68% and 90%, respectively. However, the accuracy of plain lateral neck radiograph in diagnosis of FB in hypopharynx and cervical esophagus (combined sensitivity 58% and specificity 100%) were satisfactory and higher than oropharynx (sensitivity 30% and specificity 90%). The 23 oropharyngeal FB could be found by oral and pharyngeal examination with 21 being removed at the clinics under local anesthesia.

Conclusion: Lateral neck radiography has higher detection rate for ingested FB that lodged in the hypopharynx or esophagus than in the oropharynx. It should be done after negative oral and pharyngeal examination, which most of the oropharyngeal FB could be found and removed. Appropriate direct laryngoscopy and/or rigid esophagoscopy should be considered according to the clinical symptoms and results of plain lateral neck radiography.

Keywords: Lateral neck radiograph, Foreign Body, Sensitivity, Specificity

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Foreign bodies [FB] in the digestive tract are common problems that occur in both children and adults. Failure to make the correct diagnosis can lead to delay management and serious complications such as esophageal perforation, retropharyngeal abscess, mediastinitis, lung abscess, and a rare fatal condition of esophago-aortic fistula[1].

Foodborne FB are the most common FB in digestive tract, in particular fish and chicken bones. Fish bones are the leading FB among many Asian countries in both adult and children[1-8]. Thai people share a common food among most Asian countries, eating many kinds of fish and have many ways of cooking such as fried, steamed, or boiled as soup. In contrast to the western cooking where the fish bones are usually removed before cooking, most Thai fish dishes are cooked and served with bones, no matter large or small. Small fish bones tend to get stuck more often at the pharyngeal level than at the esophagus, while large fish bones, poultry bones, food bolus, and denture tend to get stuck in the esophagus. Supracricoid symptoms and lateralization correlates well with the presence of FB especially at the pharyngeal level, while cricoid and infracricoid symptoms are less reliable[4,9].

Lateral neck radiograph is considered of limited value in detecting FB especially for small fish bone in the ororpharyngeal region[10,11]. Anyhow, the visibility depends mainly on location, follow by type of fish and orientation of the foreign bodies. Lateral neck film is still frequently employed at the emergency room as it is fast, cheap, and available. The film can also detect complications from perforation by FB[8].

Correspondence to:

Chongkolwatana C. Department of Otorhinolaryngology, Siriraj Hospital, 2 Wang Lang, Bangkoknoi, Bangkok 10700, Thailand.
Phone: +66-2-4198047, **Fax**: +66-2-4198044
Email: cheerasook@hotmail.com, cheerasook.cho@mahidol.ac.th

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The aim of the present study was to determine the accuracy of plain lateral neck radiography in diagnosis of FB in the oropharynx, hypopharynx, and cervical esophagus.

Materials and Methods

A prospective study was done at the Ear Nose and Throat out-patient clinic and emergency room at Siriraj Hospital, Bangkok, between November 2010 and December 2011. The present study was approved by the Siriraj Institutional Review Board [SIRB], Faculty of Medicine Siriraj Hospital, Mahidol University, 543/2553 (EC3). The sample size was calculated from the sensitivity of lateral neck radiography by Wu et al[12] to be 56 patients.

All patients that presented with suspicious history of foreign bodies and sudden onset of FB sensation, sore throat, or dysphagia were enrolled. Pregnant women were excluded to avoid radiation exposure. All patients initially signed the informed consent. The history and general physical examination were taken and followed by lateral neck radiography. To avoid distortion and falsely widen prevertebral soft tissue, the film was taken at the end of inhalation when the patients were standing in true lateral position with neck extended comfortably. The patients must not swallow. A horizontal ray was centered to the middle of the neck at the level of thyroid eminence. The collimation included anterior and posterior soft tissue at the neck, nasopharynx, and down to T2 vertebrae. Anteroposterior and lateral chest radiography would also be done in cases with suspicion of esophageal FB. The patients then had ENT examination with tongue depressor, indirect laryngoscopy, and occasionally rigid endoscopy. If FB were found, they would be removed under local anesthesia. If the FB could not be found, patients with mild symptoms above cricoid level and negative finding film would be discharged but scheduled for close follow-up on the next day and a week later. Patients with persistent or severe symptoms, with positive finding on lateral neck film, with suspicion of esophageal foreign bodies, and with difficulty to manipulate or who could not tolerate awaked removal would be carefully examined by direct laryngoscopy and rigid esophagoscopy in the operating room under general anesthesia where the FB would be removed. Suspicious FB in esophagus were considered if the patients has persistent midline infracricoid symptoms[4,9] or "ingestion of FB that was likely to lodge in the esophagus such as a partial denture".

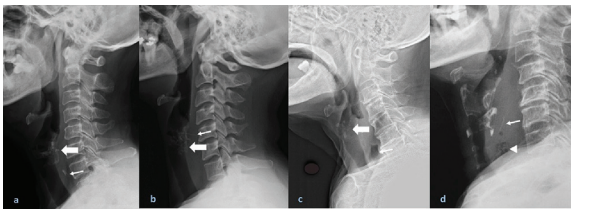

Figure 1. Lateral soft tissue neck radiograph, (a) fish bone in cervical esophagus (thin arrow) and calcified base of arytenoid cartilage (thick arrow) that can mimic the horizontal fish bone. (b) Fish bone stuck to pharyngeal wall at arytenoid (thin arrow) and calcified cricoid cartilage (thick arrow) that can mimic the vertical fish bone. (c) Foreign body with air column in esophagus (thin arrow) due to food bolus that distend the esophageal lumen and calcified thyroid cartilage (thick arrow). (d) Prevertebral soft tissue thickening with mottled air density (arrow head) due to pharyngeal perforation from the fish bone (thin arrow) and the prevertebral soft tissue was thicker more than 100% of the width of the body of C6 vertebrae. a and b were the lateral neck radiographs from the patients in this study. c and d were the lateral neck radiographs from other patients in the authors' department.

All films were reviewed by experienced radiologist (Tongdee R) who was blinded to the clinical results. The criteria for positive finding were[13] at least one of the following signs (Figure 1):

1. FB shadow.

2. Soft tissue swelling in prevertebral area; 50% or more of the width of the body of adjacent vertebrae at C2 level or 100% or more of the width of the body of adjacent vertebrae at C6 level.

3. Air in the prevertebral soft tissue as air column (found in dilated esophagus) or mottled air (found in perforation or infection).

Statistical analysis

Sensitivity and specificity of the plain lateral neck radiography were analyzed by descriptive statistics. The gold standard criteria for the presence of FB were presence of FB by oral or pharyngeal examination, direct laryngoscopy, or rigid esophagoscopy.

Results

Fifty-seven patients were included in the present study, 21 (36.8%) were male and 36 (63.2%) were female. Mean age was 49.5±20 years (1 to 94 years). Thirty patients (52.63%) were 50 years old and over. The symptoms are shown in Table 1. Foreign bodies were found in 47 of 57 patients. The types of FB are shown in Table 2. Fish bone was the most common FB. Among 38 fish bones, eight were small fish bones from short-bodies mackerel (*Rastrelliger brachysoma*),

Table 1. The symptoms of 57 patients

Symptoms	No. of patients (%)
Pricking sensation (sensation of FB)	49 (86.0)
Sorethroat	41 (71.9)
Dysphagia	21 (36.8)
Refusal to eat	8 (14.0)
Drooling	4 (7.0)
Choking	2 (3.5)

FB = foreign body

Most people had more than 1 symptom

Table 2. Types of foreign bodies

Types of foreign bodies	No. found (%)
Fish bone	38 (80.9)
Poultry bone	3 (6.4)
Other food (fruit seed, part of shrimp)	3 (6.4)
Denture	1 (2.1)
Drugs (tablet in press-through package)	1 (2.1)
Coin	1 (2.1)

FB = foreign body

Fish bones were the most common FB in digestive tract

Table 3. No. of positive radiographic finding by each criteria/No. of FB found

Criteria for positive radiographic finding	No. of positive finding for each criteria/No. of FB found			
	Oropharynx, FB found = 23	Hypopharynx, FB found = 9	Cervical esophagus, FB found = 15	Total, FB found = 47
FB shadow	6/23	4/9	6/15	16/47
Soft tissue swelling	1/23	2/9	2/15	5/47
Total (% detection rate)	7/23 (30.43)	6/9 (66.66)	8/15 (53.33)	21/47 (44.68)

FB = foreign body

There was no case with finding of air in prevertebral soft tissue. There was no FB in thoracic esophagus in this study. The detection rate of lateral neck radiography for 3 different locations is shown in the bottom line. One case with false positive radiograph was not included for calculation.

which is popular fish dishes in Thailand. FB in oropharynx was fish bone only. All 23 oropharyngeal FB were found by pharyngeal examination and could be removed at the clinics in 21. There were two tonsillar-FB patients who were less than five years old and could not tolerate awake removal. The FB were removed by using forceps and tongue depressor or rigid laryngoscopy under local anesthesia in 22 patients. Among this group, FB were located at the oropharynx in 21 cases (tonsil 11, vallecular area 4, base of tongue 5, posterior pillar 1) and one at the hypopharynx (posterior pharyngeal wall). Twenty-five patients had direct laryngoscopy with or without rigid esophagoscopy under general anesthesia. FB were found and removed in all 25 patients. Two were at the oropharynx (tonsil 2), eight were at the hypopharynx (posterior pharyngeal wall 4, pyriform sinus 1, post cricoid 3), and 15 were at the cervical esophagus. Ten patients who had mild supracricoid symptoms and initial negative radiographic finding and negative ENT examination were discharged from the clinics and scheduled for follow-up the next day and at one week. FB was not found during follow-up although on one patient of this group, the film was later considered positive for FB at the oropharyngeal level by expert review. All symptoms resolved in these 10 patients and they had no problems later. All patients in the present study came to hospital within 24 hours after FB ingestion and there was no perforation or other complications. Computed tomography [CT] scan was not done in any patient of the present study.

Table 4. Overall sensitivity and specificity of plain lateral neck radiography to diagnose FB at oropharynx or hypopharynx or cervical esophagus

Radiographic finding for FB	Foreign bodies found by examination or endoscopy		Total
	Yes	No	
Positive	21	1*	22
Negative	26	9	35
Total	47	10	57

FB = foreign body

* One case with false positive radiograph for FB in oropharynx

Sensitivity was 44.68% with 95% CI 31 to 59, specificity was 90% with 95% CI 60 to 98, positive predictive value was 95% with 95% CI 78 to 99, and negative predictive value was 26% with 95% CI 14 to 42

The detection rate of lateral neck radiography among different sites of foreign bodies showed the lowest rate in the oropharynx (30.43%) and higher in the hypopharynx (66.6%) and the cervical esophagus (53.33%) (Table 3). Overall sensitivity and specificity of plain lateral neck radiography to diagnose FB at oropharynx or hypopharynx or cervical esophagus was 44.68% (95% CI 31 to 59) and 90% (95% CI 60 to 98), respectively, as shown in (Table 4). Analysis of the accuracy of the plain lateral neck radiography to diagnose FB at different sites i.e., oropharynx, hypopharynx, or cervical esophagus revealed that 1) the accuracy of plain lateral neck radiograph in diagnosis of FB in the oropharynx has sensitivity of 30% (95% CI 13 to 53) and specificity of 90% (95%

Table 5. Sensitivity and specificity in each location

Location	Sensitivity (%)	95% CI	Specificity (%)	95% CI	PPV (%)	95% CI	NPV (%)	95% CI
Oropharynx	30	13 to 53	90	56 to 100	88	50 to 98	36	29 to 44
Hypopharynx	67	30 to 93	100	66 to 100	100	?	75	55 to 88
Cervical esophagus	53	27 to 79	100	66 to 100	100	?	56	43 to 69
Hypopharynx and cervical esophagus	58	36 to 79	100	66 to 100	100	?	47	35 to 59

CI = confidence interval; PPV = positive predictive value; NPV = negative predictive value; ? = not available

Nine patients with true negative result were used in all calculation of each subgroup

CI 56 to 100), 2) the accuracy of plain lateral neck radiograph in diagnosis of FB in the hypopharynx or cervical esophagus has sensitivity of 58% (95% CI 36 to 79) and specificity of 100% (95% CI 66 to 100), 3) the accuracy of plain lateral neck radiograph in diagnosis of FB in the hypopharynx has sensitivity of 67% (95% CI 30 to 93) and specificity of 100% (95% CI 66 to 100), and 4) the accuracy of plain lateral neck radiograph in diagnosis of FB in the cervical esophagus has sensitivity of 53% (95% CI 27 to 79) and specificity of 100% (95% CI 66 to 100) (Table 5).

Discussion

Diagnosis of FB ingestion depends on the history and presenting symptoms. The most common symptoms were pricking sensation and sore throat, which was the same as other reports[2,3]. The present study confirmed that fish bone was the most common FB, which was the same as other Asian countries as they share the common preference of serving fish dishes with bone. The most common location was the oropharynx. Small fish bones tend to stick to the mucosa of the oropharyngeal area especially the tonsil. During oral and pharyngeal phase of swallowing, the base of tongue presses the food against the pillar and the tonsil. Because the consistency of the tonsil and the base of tongue are firm and non-slippery, it makes it easy for small and sharp FB like fishbone to get stuck.

Many reports mentioned the low value of plain radiography in the diagnosis of ingested FB[3,10,14]. Overall sensitivity in the present study was 44.68%, which is higher than most reports (Wai et al; 15.95%[3], Evans et al; 25.3%[10], Devarajan et al; 24%[16], Ngan et al; 32%[15]) but comparable to Wu et al (57.45%)[12], which is probably because of the clear definition of positive radiographs and expert review of all films before statistical analysis.

The authors' results showed lower detection rate (30.43%) in the oropharynx, probably because the most common FB in this area was fish bone, which was small and sometimes not radio-opaque. Of 38 fish bones, eight were from short-bodies mackerel (*Rastrelliger brachysoma*), which has very small and thin bones. The oropharynx has complex overlapping structures of soft tissue, bone, and cartilage. The laryngeal cartilage's ossification and calcification are part of the aging process and can be seen on radiograph after the second decade of life. Castán Senar et al (2017) compared lateral neck radiographs and CT scan and listed common errors of many neck structures that mimic FB in radiographs[8], for examples, calcified stylohyoid ligament, ossification of posterior lamina of thyroid cartilage, ossification of superior cricoid lamina, or ossification of arytenoid base (Figure 1). All of these contribute to poor visibility or misinterpretation of FB by radiographs. Emergency room physicians and otolaryngologists should be trained to understand the clinical use and limitation of radiograph. Lue et al[17] reported that fish species, location, and orientation affect visibility of fish bone in lateral neck radiography. Our radiographic detection rate for hypopharynx and esophagus was 66.66% and 53.33%, respectively, which were much higher than in the oropharynx (30.43%). FB location had influence on detection rate of lateral neck radiography. Recent report by Sanei-Moghaddam et al[11] found only 10% (23/229) positive lateral neck film for oropharyngeal FB.

Most oropharyngeal FB can be seen by examination with tongue depressor, indirect laryngoscopy, rigid endoscopy, or flexible endoscopy[2,6]. In the present study, 21 of 23 oropharyngeal FB were found by paryngeal examination and could be removed under local anesthesia. Only two needed general anesthesia for removal. Flexible scope was not available at emergency room and was not used in the present study. Before radiography, thorough oral and pharyngeal examination should be done with special attention to tonsils as it was the most common site of oropharyngeal FB (Table 6) in the present study and in other reports[2,3]. There is a high possibility that the oropharyngeal FB can be detected and removed without any radiographic investigation. Lateral neck radiographs should not be routinely used as first seen for all FB suspicious patients.

Table 6. Location of foreign bodies among 47 patients

	n (%)
Oropharynx: fish bone only	23 (48.9)
Tonsils	13 (27.7)
Base of tongue	5 (10.6)
Valleculae area	4 (8.6)
Posterior pillar	1 (2.1)
Hypopharynx	9 (19.1)
Pharyngeal wall	5 (10.6)
Post cricoid area	3 (6.4)
Pyriform sinus	1 (2.1)
Cervical esophagus	15 (31.9)

There was no FB in thoracic esophagus in this study

Although many recent reports suggest that CT scan have high sensitivity and specificity[17,18], it is not available in all situations. Lateral neck radiography is fast, cheap, and available and still has a significant role in detecting FB, especially in the hypopharynx and the esophagus. The plain lateral neck radiography is specific enough to make decision for pharyngoesophagoscopy under general anesthesia without further imaging and is still justified as the first diagnostic option after complete oral and oropharyngeal examination. CT scan should be reserved for complicated cases of FB, such as suspicious of complication, suspicious of migration, and previous failure of removal.

All patients in the present study came early, before 24 hours after ingestion, because of the high public awareness for FB and the easy access to hospital in a big city. We encountered no complication as most perforation occurred after 24 hours of impaction[1].

Conclusion

Plain lateral neck radiography has low accuracy to diagnose FB at the oropharynx and has satisfactory accuracy to diagnose FB at the hypopharynx or at the cervical esophagus. From the present study results, it is recommended that direct examination of oral cavity and pharynx be performed in patients presenting with FB ingestion. Most of the oropharyngeal FB, and some of hypopharyngeal FB, could be found and removed. If FB is not found, plain lateral neck radiography should be done to determine the presence of FB at the hypopharynx or at the cervical esophagus and appropriate direct laryngoscopy and/or rigid esophagoscopy is considered according to the clinical symptoms and results of plain lateral neck radiography.

What is already known on this topic?

Lateral neck radiography is considered to be the cost-effective investigation to detect FB in pharynx and esophagus. The visibility of FB depends mainly on location, followed by type of fish and orientation of the foreign bodies.

What this study adds?

Lateral neck radiography has higher accuracy to detect FB in the hypopharynx and in the esophagus than FB in the oropharynx.

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Potential conflicts of interest

The authors declare no conflict of interest.

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