"ROLE OF FLEXIBLE BRONCHOSCOPY IN EARLY DIAGNOSIS AND MANAGEMENT OF LARYNGOTRACHEOBRONCHIAL FOREIGN BODIES"

By

Dr. Anuja M Panicker

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Under the guidance of

Dr. H T Lathadevi

Professor and HOD Department of OTORHINOLARYNGOLOGY

BLDE (DEEMED TO BE UNIVERSITY)

SHRI B.M. PATIL MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE, VIJAYAPURA, KARNATAKA.

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LIST OF ABBREVIATIONS

%	Percentage
FB	Foreign Body
FL. BR.	Flexible Bronchoscopy
RUL	Right Upper Lobe
RML	Right Middle Lobe
RLL	Right Lower Lobe
LUL	Left Upper Lobe
LLL	Left Lower Lobe
PPV	Positive Predictive Value
NPV	Negative Predictive Value
SEN	Sensitivity
SPE	Specificity

ABSTRACT

INTRODUCTION:

Foreign body aspiration is a common problem that requires early diagnosis and immediate treatment to minimize the potentially serious and fatal consequences. Flexible bronchoscopy has got a very important role in early diagnosis of foreign bodies of airway in suspicious cases of foreign body aspiration, in patients of unresolved pneumonia or in cases of airway diseases not responding to medical treatment.

AIMS AND OBJECTIVES OF THE STUDY:

1. To show that flexible bronchoscopy plays a major role in early diagnosis of foreign bodies of the airway.

2. To show the role of flexible bronchoscopy in reducing negative rigid bronchoscopies.

3. To study the indications of flexible bronchoscopy in suspected foreign bodies.

METHODOLOGY:

In a hospital based cross sectional study, done in 36 patients with suspicion of foeign body airway from November 2019 to August 2021, role of flexible bronchoscopy was studied in early diagnosis and management of laryngotracheobronchial foreign bodies. Proper history is taken and physical examination is done in all patients with history of foreign body aspiration and in those with suspicion of foreign body in airway. Chest X ray is done in all patients and based on the above findings and high index of suspicion, patients are subjected to Flexible bronchoscopy and if foreign body is visualised, then removal is done by rigid bronchoscopy. Common presentation, X ray findings and other variables and associations were evaluated.

RESULTS:

Out of 36 patients, 16 presented with history of foreign body aspiration and 3 presented with doubtful history and 17 presented with negative history. On flexible bronchoscopy, all of the positive and doubtful history group had foreign body and 14 out of 17 in the negative history group had foreign body. Hence flexible bronchoscopy plays a major role in early diagnosis of foreign bodies in suspicious cases.

In our study, 32 patients had foreign body in airway on flexible bronchoscopy. Among the 19 patients who presented within 3 days of symptoms 17 had normal Xray and among 13 patients who presented after 3 days of symptoms, 11 had abnormal Xray and. Hence X ray alone is not a deciding factor in case of foreign body aspiration.

CONCLUSION:

Foreign body aspiration is a life threatening emergency which may result in sudden death if not treated promptly. Early diagnosis and timely intervention saves the life of the patient and hence helps in avoiding pulmonary complications and morbidity associated. Flexible bronchoscopy plays a major role in early diagnosis of airway foreign bodies and its further management.

KEY WORDS:

Flexible bronchosopy, Foreign body bronchus.

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INTRODUCTION

Problems of dealing with the foreign body either, swallowed or aspirated, are as old as humanity. In such cases, no definitive treatment was available, so mortality and mobility were very high. People tried doing manoeuvres like making the child inverted, patting the back, putting the finger in the pharynx, etc. Rational management of such cases started only after Gustav Killian performed bronchoscopy for the first time to remove a foreign body in 1897[(61)].

Though bronchoscopy remains the mainstay of treatment even today, advances in bronchoscopes, forceps, anaesthesia techniques, higher broad-spectrum antibiotics and corticosteroids have increased the efficacy of the procedure to a great extent.

Foreign body aspiration accidents occur because parents give children unsuitable or inedible objects to eat or to play. In adults, it is due to faulty food habits. Bronchoscopists have removed various foreign bodies from the tracheobronchial tree from beans, nuts, seeds, bones, toys, teeth, pencil caps, nails, pins, tracheostomy tubes, endotracheal tubes, etc.

Foreign body in the tracheobronchial tree is a potentially fatal condition if not managed properly. A foreign body in the bronchus can simulate lower respiratory tract infections and is likely to be missed if the medical attendant doesn't carry an index of suspicion.

Aspiration of the foreign body is a preventable accident hence, steps should be taken to reduce the incidence by educating parents about the dangers of this accident and its eventualities.

In this study the role of flexible bronchoscopy in early diagnosis and management of laryngotracheobronchial foreign bodies is studied.

AIMS AND OBJECTIVES

1. To show that flexible bronchoscopy plays a major role in early diagnosis of foreign bodies of the airway.

2. To show the role of flexible bronchoscopy in reducing negative rigid bronchoscopies.

3. To study the indications of flexible bronchoscopy in suspected foreign bodies.

REVIEW OF LITERATURE

HISTORY

Management of foreign bodies in airway started with the invention of bronchoscope. Without the help of the scope it is almost impossible to remove the foreign body from the tracheobronchial tree.

The credit of first foreign body removal from the bronchus goes to Gustav Killian from Freiberg. He removed a piece of bone on 30th March 1897 from right main bronchus of a 63 years old male using a Mikulicz- Rosenheim rigid scope with a set of extra long forceps demonstrated the endoscopic feasibility of removal of foreign body from the tracheobronchial tree. He has been honourably recognised as "Father of Bronchoscopy" [(60)].

Prior to this people have tried to visualise the upper GIT, larynx and tracheobronchial tree.

In 1855 Manuel Garcia a Spanish singing teacher, living in London, first reported the visualisation of larynx with reflected lights and mirror.

In 1856, Turck and Czermak in Vienna, developed first direct laryngoscope.

In 1878 Thomas Edison developed the electric lamp and overcame the hurdles of difficult distal visualisation.

In 1879, first distally illuminated endoscope (cystoscope) was developed by Nitzi.

Joseph O Dwyar of New York devised a tracheostomy tube of large calibre and thin walls, for expulsion of foreign bodies from trachea and bronchus. The tube was inserted into larynx, the patient placed on this back and an attempt to remove the foreign body was made by coughing.

At the turn of this century, Chevalier Jackson of Philadelphia introduced a distally illuminated bronchoscope, with right angle handle to the scope.Similar changes were made in laryngoscopes and esophagoscopes by him. He developed the largest school and clinic of endoscopy on either side of Atlantic. His contributions to the understanding and art of removing foreign bodies from food and air passages has been excellent. Conventional lens system which was introduced by Jackson was changed with Hopkins rod lens telescope system [(28)].

Additional advances in rigid bronchoscopy were possible with the invention of optical telescope by Boyle's and the introduction of solid rod lens optical system by Hopkins. In 1974, H.H. Hopkins of Reading University invented the system which consists of air containing spaces in conventional series of lenses which are replaced by glass rods with polished ends and seperated by "Air Lenses" This gives more illumination more magnification and wider angle.

In 1930, Lamm developed fibre optic principles for lighting. However Ikeda in 1988 used the same principles for bronchoscopy and made flexible fiberoptic scope.

In 1965 Hollinger incorporated fibre carrier and rigid bronchoscopes and with this rigid illuminated bronchoscopes reliability increased to a great extent.

Documentation and teaching bronchoscopy have been made possible by Hollinger-Brubaker camera. Rayl's work with documentation through colour television merits admiration.

With the help of image intensifier a radio opaque foreign body lying deep in the bronchial tree can be removed. A double tubed Fluoroscope is used to guide the scope.

Advances in bronchoscopes and optical forceps are of a great help in foreign body removal.

EMBRYOLOGY OF LOWER RESPIRATORY TRACT

During the fourth week of embryonic development, the rudiment of the respiratory tree appears as a median laryngotracheal groove in the ventral wall of the pharynx. The groove subsequently deepens, and its edges fuse to form a septum, thus converting the groove into a splanchnopleuric laryngotracheal tube. This process of fusion commences caudally and extends cranially, but does not involve the cranial end where the edges remains separate, bounding a slit like aperture, through which the tube opens into the pharynx.

The epithelial lining of respiratory tract develops from the endoderm that lines the tube. From the cranial end of the tube forms larynx and trachea and the caudal end produces two lateral outgrowths from which the connective tissue, cartilage, non striated muscle and the vasculature of the bronchi and the lungs develop.

LARYNX AND TRACHEA

Cranial end of the laryngotracheal groove gives rise to primitive larynx, which is bounded laterally by the ventral fold of the sixth arch and vertically by the caudal part of the hypobranchial eminence. The arytenoid swellings appear on either side of the groove and as they enlarge, gets approximated to each other and also to the caudal part of hypobranchial eminence from which epiglottis develops. The opening into the laryngeal cavity develops as a vertical slit or cleft, which becomes T- shaped with the appearance of arytenoids. The aperture of the larynx is occluded due to fusion of the epithelial walls of the cleft, until the third month when it's lumen is restored. The arytenoid swellings grow upwards and deepen to produce the primitive aryepiglottic folds.

This, in turn, produces a further aperture above the level of the primitive aperture which becomes the glottis. During the second month of fetal life, the arytenoid swellings differentiate into the arytenoid and corniculate cartilages (derivatives of 6th arch) and the folds joining them to the epiglottis become the aryepiglottic folds from which the cuneiform cartilage develops as the derivative of epiglottis. From the ventral ends of the cartilages of fourth branchial arch, develops the thyroid cartilage. The cricoid cartilage and cartilages of the trachea developed in the 6th branchial arch during the sixth week. From the fifth week, the trachea increases in length.

The branchial nerves of the fourth and sixth arches, namely the superior laryngeal and recurrent laryngeal nerves supply the larynx.

BRONCHI AND LUNGS

The right and the left lung buds that appear in front of the laryngotracheal groove is converted into a tube. They grow out into the pleural passages caudal to the common cardinal veins and divide into lobules, three appearing on the right and two on the left.

The primary bronchus continues to divide dichotomously until birth and about 18-23 generations of divisions have appeared which are not always equal in the individual lobes. There has been considerable discussion concerning how much of the subsequent development of the bronchi and alveoli takes place after birth. The current views are summarised by Reid (1967) in her three laws on lung development:

1) By the sixteenth week of intrauterine life, the bronchial tree is fully developed.

2) Alveoli as commonly, develop after birth, which keeps on increasing in number until the age of 8 years and in size until chest wall growth is completed.

3) While new alveoli are forming, blood vessels are remodelled and increased in number

ANATOMY OF LARYNX

Anatomically as such, larynx is not considered as a part of upper respiratory tract, but developmentally and physiologically and even pathologically the larynx behaves as a part of the lower respiratory tract. Part of larynx from the level of vocal cords and below is considered as a part of lower respiratory tract[9].

The larynx which acts as the air passage, a sphinteric device and an organ of phonation, extends from the tongue base to trachea. It is covered anteriorly by skin, fascia and the hyoid depressor muscles and projects ventrally between the great vessels of the neck and. Above, it opens into laryngopharynx and forms its anterior wall. Below it continues into the trachea. In adult males it lies opposite to 3rd to 6th cervical vertebrae, although somewhat higher in children and adult females. In infanys between 6 and 12 months, the tip of epiglottis (the highest part of the larynx) is a little above the junction of the dense and body of the axis vertebrae. Its average measurements in adults are :

	In males	In females
Length	44mm	36mm
Transverse diameter	43mm	41mm
Sagital diameter	36mm	26mm

TABLE-1: MEASUREMENT OF LARYNX

Until puberty, the male and female larynx are similar in size, but afterwards the male larynx enlarges considerably in comparison with the female.

SKELETON OF THE LARYNX

Set of paired and unpaired cartilages form the skeletal framework of the larynx, which are interconnected by ligaments and fibrous membrane moved by a number of muscles.

Laryngeal cartilages

They comprise of the single Cricoid, Thyroid, Epiglottic cartilage and the paired arytenoids, cuneiform and corniculate cartilages.

Thyroid cartilage

The shield like cartilage is the longest of the laryngeal cartilages and consists of 2 quadrilateral laminae whose anterior border fuses along their inferior 2/3rd at a median angle forming the subcutaneous laryngeal prominence, (Adams apple) and separated above by the V- shaped superior thyroid notch. The angle of fusion of thyroid laminae is about 90 degrees in men and 120 degrees in women. The laminae diverge posteriorly, and the posterior border of each is prolonged as 2 slender processes – the superior and inferior cornua. The superior cornu is long and narrow curving upwards, backwards and medially and is attached to the lateral thyroid ligament. The inferior cornu is short and thick and curves downwards ad medially where it articulates with the cricoids cartilage.

On the external aspect of each lamina is the oblique line, which marks the attachments of thyrohyoid, sternothyroid and inferior constrictor muscles. The inner aspect of the lamina are covered by loosely attached mucous membrane and are smooth. To the thyroid notch's inner aspect, the thyroepiglottic ligament is attached and below this level, on either side of the midline the vestibular and the vocal ligaments and the thyroarytenoid, thyroepiglottis and vocalis muscles are attached. The upper border of each lamina gives attachment to the corresponding half of the

thyrohyoid ligament. To the inner aspect of the inferior border of the thyroid cartiage's medial portion, the cricothyroid membrane is attached.

Cricoid cartilage:

It can be regarded as the skeletal foundation of larynx being the only complete ring in the air passage.It is like a signet ring, comprising of a deep road quadrilateral lamina posteriorly and a narrow arch anteriorly.(It is attached low to trachea and articulated by synovial joints to thyroid and arytenoid cartilages).

At the junction of arch and lamina, an articular facet is present for inferior cornu of thyroid cartilage. Articular facets for the arytenoid cartilage are present on the lamina. A vertical ridge in the midline of lamina gives attachment to the longitudinal muscles.

On the external aspect of front and sides of cricoid arch,cricothyroid muscle is attached. The internal surface of the cricoid is smooth and lined by mucous membrane.

Arytenoid Cartilage

The paired arytenoid cartilages are placed on the lateral part of cricoids lamina's superior border at the back of the larynx. Each is pyramidal in shape with three surfaces, two processes- a base and an apex. The posterior surface is triangular and covered by transverse arytenoid muscle. The antero-lateral surface is convex and rough; the upper part of which gives attachment to the vestibular ligament and the lower part to the vocalis and lateral crico aryrtenoid muscles. The lower edge forms the lateral boundary of the inter-cartilagenous part of the rima glottidis and the medial surface, covered by mucosa is narrow, smooth and flat. The base is concave for articulation with cricoid lamina. The round, prominent lateral

angle or muscular process projects backwards and laterally giving attachment to the posterior crico-arytenoid muscle behind and the lateral crico-arytenoid muscle in front. To its pointed anterior angle (vocal process) projecting horizontally fc ard is attached the vocal ligament. The apex curves backwards and medialy to ticulate with the corniculate cartilage.

The Corniculate Cartilage:

These are two conical nodules of elastic fibro cartilage which articulate with the apices of arytenoid cartilages prolonging them postero-medially and lie in the posterior parts of the aryepiglottic mucosal folds and are sometimes fused with arytenoid cartilages.

The Cuneiform Cartilage:

These cartilages are two small elongated club like nodules of elastic fibrocartilage,one in each aryepilottic fold anterosuperior to the corniculate cartilages and visible as whitish elevations through the mucosa.

The Epiglottic Cartilage:

It is thin leaf like plate of elastic fibrocartilage, projecting obliquely upwards behind the tongue and hyiod body and in front of laryngeal inlet. Its free end which is broad and rounded is directed upwards; The attached part or stalk (Petiolus) is long, narrow and is connected to the back of thyroid cartilage by the elastic thyroepiglottic ligament. Its attached to the arytenoid cartilages by aryepiglottic folds on both sides. Its free anterior surface is related to vallecula and glossoepiglottic folds. Its superior margin is free. The smooth posterior surface is vertically concavo-convex and transversely concave. It is covered by respiratory mucosa which is ciliated. Its lower projecting part is the tubercle. The cartilage is

pitted posteriorly by small mucous glands and perforated by branches of the internal laryngeal nerve.

Tritiate Cartilage:

(Cartilago triticea) They are two small nodules of elastic cartilages within the posterior free edge of thyrohyoid membrane.

Microstructure of Laryngeal Cartilage

The corniculate, cuneiform, tritiate, epiglottis and apices of arytenoids are composed of elastic fibrocartilage with little tendency to calcify. The thyroid, cricoid and greater part of arytenoid consists of hyaline cartilage which begin to calcify in person's late teens or early twenties.

Membranes and Ligaments of Larynx

Extrinsic Ligament:

The extrinsic ligaments connect the laryngeal cartilage to hyoid and trachea.
Thyrohyoid Membrane:

It is a broad,fibroelastic layer, attached below to the superior border of thyroid cartilage, lamina and the anterior aspect of its superior cornua; above, it is attached to the superior margin of the posterior surface of the hyoid bone's body and greater cornu.

The median anterior part is thick and forms median thyrohyoid ligament. The lateral thinner parts are pierced by the superior laryngeal vessels and internal laryngeal nerve.The round,cord like elastic lateral thyrohyoid ligament forms the posterior border of the thyrohyoid membrane,connecting the tips of the

superior thyroid cornu to the posterior end of greater hyoid comu. A small cartiligo triticea occurs frequently in each ligament.

Cricotracheal Ligament unites the lower cricoid border to the first tracheal ring being thus continuous with the tracheal perichondrium. The hyoepiglottic ligament- connects the epiglottis to the back of the body of hyoid.

Intrinsic Ligament

The intrinsic ligaments connect the cartilages themselves, and together they strengthen the capsules of intercartilagenous joints and form the broad sheet of fibroelastic tissue, the fibroelastic membrane which lies beneath the mucous membrane of larynx which thus creates an internal framework.

The laryngeal ventricle divides the fibroelastic membrane into an upper and lower part. The upper quadrilateral membrane extends between the lateral border of epiglottis and arytenoid cartilage. The upper margin of this forms the framework of aryepiglottic fold; lower margin is thickened to form the vestibular ligament which lies below the false cord.

The lower part is a thicker membrane commonly called as cricovocal or cricothyroid ligament or the conus elasticus. Above, it's stretched between the midpoint of laryngeal prominence of thyroid cartilage anteriorly and vocal process of arytenoid behind and attached below to the upper border of cricoid cartilage. The free upper border of this constitutes the vocal framework of true cord or vocal fold. Anteriorly there is a thick cricothyroid ligament.

The Interior of The Larynx (Figure 1)

The cavity of larynx extends from the lower end of pharynx at the laryngeal inlet to the lower border of cricoid cartilage. Its divided by the vocal and vestibular folds into three compartments. The superior vestibule lies above the vestibular folds, the

ventricle or sinus of the larynx lies in between the vestibular and vocal folds and the subglottis extends from the vocal folds to the lower border of cricoid cartilage.

The laryngeal inlet is superiorly bounded by the free edge of epiglottis and on each side by aryepiglottic folds and posteriorly by mucous membrane between the two arytenoid cartilages. The fissure between the two vestibular folds are called rima vestibuli and that between the two vocal folds is called the rima glottidis. The vestibular folds are two thick, pink folds of mucous membrane, enclosing a narrow band of fibrous tissue, the vestibular ligament which is fixed infront to the angle of thyroid cartilage, just below the attachment of epiglottis and behind to the anterolateral surface of the arytneoid cartilage, just above the vocal process.

The vocal folds extend between the middle of the angle of thyroid to the vocal process of the arytenoid. Each fold is a layered structure made up of muscle and mucosa. The mucosa is subdivided into epithelium-stratified squamous epithelium and lamina propria which consists of superficial, intermediate and deep layers. The superficial layer of lamina propria referred to as Reinke's space consists of loose fibrous substance like soft gelatin. It is this layer which vibrates most significantly during phonation. If it becomes stiff due to some pathological state such as inflammatory, tumour or scar tissue, its vibrations are disturbed and voice problems result. Intermediate layer consisting mainly elastic fibres and deep layers consisting of collagenous fibres together form the vocal ligaments deep to which is the vocalis muscle constituting the main body of vocal fold.

The glottis is an elongated fissure between vocal folds anteriorly and vocal processes and base of arytenoid cartilages posteriorly. The anterior part between

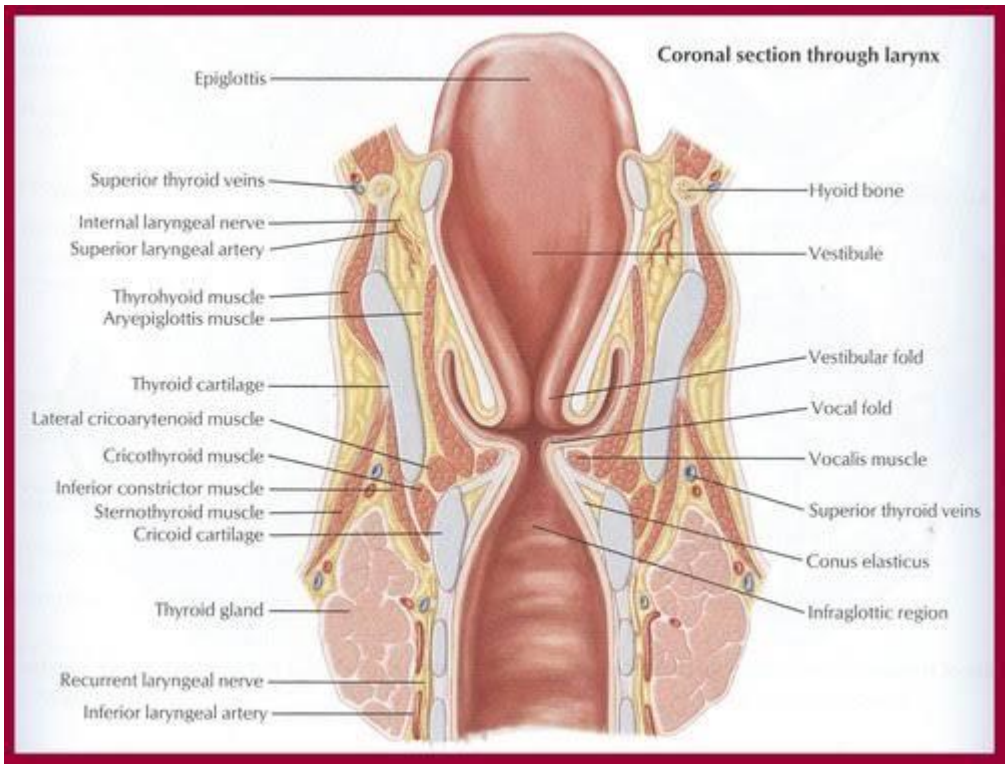

FIG-1: CORONAL SECTION OF LARYNX

vocal folds which is about 3/5th is called intramembranous part and remainder lying between the vocal process is called intercartilagenous part. The average length of glottis varies between 23mm in men and 16to17mm in women. In the resting state the vocal processes are usually 8mm apart. The glottis alters shape with phonation and respiration.

Muscles of Larynx

The muscles of larynx may be divided into extrinsic, which attach the larynx to neighbouring structures and maintain position of larynx in the neck ,and intrinsic, which move the various cartilages of the larynx and regulate the mechanical properties of the vocal folds.

Extrinsic Muscles may be divided as Suprahyoid and Infrahyoid muscles.The suprahyoid muscles include the mylohyoid, geniohyoid digastric, stylopharyngeus, palatopharyngeus and salpingopharyngeus. The mylohyoid muscle originates from the mylohyoid line on the inner aspect of the mandible and is inserted into a midline raphe with fibres from the opposite side. The midline raphe and posterior fibres are attached to the body of hyoid bone. It is supplied by the trigeminal nerve and its action is to raise the hyoid bone and pull it anteriorly.

The geniohyoid muscle extends from each inferior genial tubercle to the upper border of hyoid bone. The stylohyoid muscle arises from the back of styloid process and inserts on the base of greater cornu of hyoid bone. It is supplied by facial nerve and acts as an elevator and retractor of hyoid bone while swallowing.
The digastric muscle - The posterior belly originates from the notch on the medial surface of mastoid process. Its anterior belly originates from the digastric fossa on

the lower border of mandible. The intermediate tendon is attached by fibrous sling to lesser cornu of hyoid bone. The anterior belly is supplied by mylohyoid nerve (trigeminal) and posterior belly by facial nerve.

The stylopharyngeus muscle arises from the deep aspect of the styloid process and slopes down to attach to the posterior border of thyroid cartilage and the side of the pharynx. It is supplied by the glossopharyngeal nerve and it helps elevate the larynx.

The palatopharyngeus muscle arises from the posterior surface of the hard palate forming palatine aponeurosis and gets inserted on the posterior border of thyroid cornu and ala, it is supplied by cranial part of accessary nerve. It helps in raising and shortening the wall of pharynx.

The salpingopharyngeus muscle arises from tubal elevation and passes vertically to get inserted into posterior border of thyroid cartilage and side wall of pharynx. It is supplied by pharyngeal plexus. It elevates larynx and pharynx helping in second stage of swallowing.

Intrisic Muscles

The intrinsic muscles are of great importance in regulating the mechanical properties of the vocal folds as they control not only position and shape of the vocal folds, but also the elasticity and viscosity of each layer of the vocal folds. They may be divided into first, those that open and close the glottis, namely the posterior cricoarytenoids, the lateral cricoarytenoids, the posterior and oblique inter arytenoids, second, those that control the tension of the vocal folds, namely the thyroarytenoids(vocalis) and cricothyroids and third, those that alter the shape of the inlet of larynx namely the

aryepiglotticus. With the exeption of the transverse arytenoid, all these muscles are paired.

Blood Supply

The blood supply is derived from superior and inferior laryngeal arteries and the cricothyroid artery. The superior laryngeal artery and cricothyroid artery is a branch of superior thyroid artery whereas inferior laryngeal artery is a branch of inferior thyroid artery.

The veins leaving the larynx accompany the arteries, superior vessels entering the internal jugular vein by way of superior thyroid or facial vein. The inferior vessels drain by way of inferior thyroid into the brachiocephalic vein.

Lymphatic Drainage:

The lymphatics of larynx are seperated by vocal folds into upper and lower groups. The part of larynx above vocal folds drain into upper deep cervical lymph nodes, whereas the zone below the vocal folds drain into the lower part of the deep cervical chain often through prelaryngeal and pretracheal lymph nodes. The vocal folds are firmly bound down to the underlying ligaments and this results in an absence of lymphatics.

Nerve Supply

The nerve supply of the larynx is from the vagus by way of its superior and recurrent branches. The superior laryngeal nerve arises from the inferior ganglion of vagus and recieves a branch from superior cervical sympathetic ganglion. At the level of greater horn of hyoid it divides into external and internal branch. The external branch supplies the cricothyroid muscle. The internal branch is sensory and supplies mucus membrane of supraglottis upto the level of vocal cords.

The recurrent laryngeal nerve ascends in the neck, accompanied by inferior laryngeal artery enters the larynx behind the cricothyroid joint dividing into motor and sensory branches.The motor branch has fibres from the cranial root of accessory nerve with cell bodies lying in the nucleus ambiguous; these supply all the intrinsic muscles of larynx except cricothyroid. The sensory branch supplies the laryngeal mucus membrane below the level of vocal folds.

ANATOMY OF TRACHEOBRONCHIAL TREE

The trachea is a cartilaginous and membranous tube about 10-11 cm in length that runs from the attachment to the end of the cricoid cartilage at the level of the sixth cervical vertebra to the bifurcation at the level of the upper border of the fifth thoracic vertebra, or second costal cartilage, or the manubrio-sternal angle. Although the bifurcation is normally a little to the right of midline, the trachea is mostly in the median plane. During inspiration, the diameter of the air passages increase significantly, and during expiration, it reduces significantly.

The trachea is smaller, deeply placed, and mobile in children than in adults.

In cross section, the trachea is D shaped and has incomplete cartilaginous rings anteriorly and laterally, and a straight membranous wall posteriorly. The tracheal rings, which cause elevation and pallor of the mucosa, can be seen endoscopically in outline beneath the mucosa. In an adult male, the transverse diameter is larger than the anteroposterior diameter, measuring 20mm and 15mm, respectively.

Main Bronchus

The main bronchi are separated by a narrow ridge at their origin, which, in view of its resemblance to the keel of an upturned boat, is called the carina. The carina always contains cartilage although the actual dividing ridge is frequently membranous.

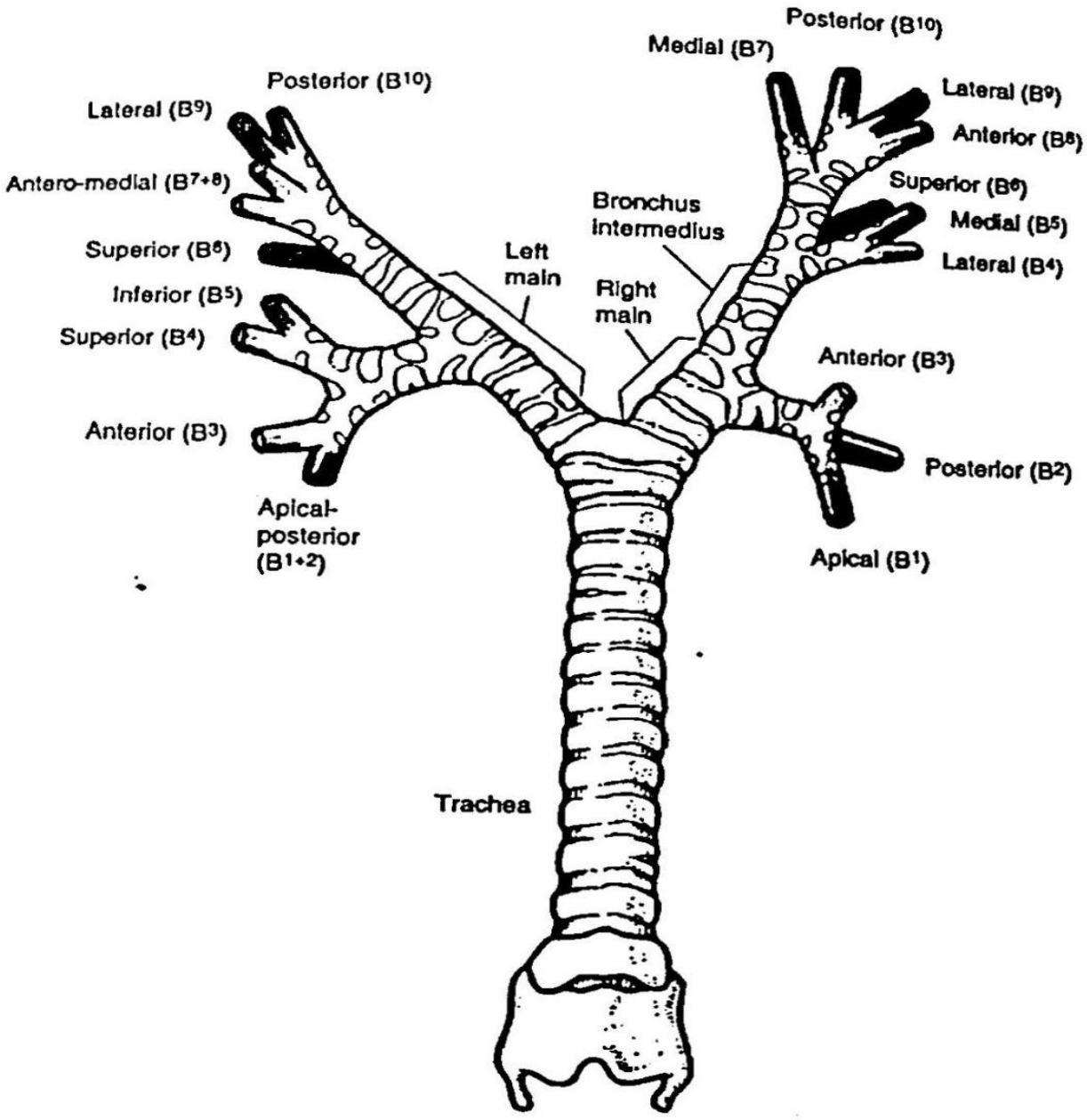

FIG2: TRACHEOBRONCHIAL TREE

Age	Average length(cm)	Average Sagital Diameter	Average Coronal Diameter
0-1 month	3.8	5.7	6
1-3 month	4	6.5	6.8
3-6 month	4.2	7.6	7.2
6-12 month	4.3	7	7.8
1-2 years	4.5	9.4	8.8
2-3 years	5	10.8	9.4
3-4 years	5.3	9.1	11.2
6-8 years	5.7	10.4	11
10-12 years	6.3	9.3	12.4
14-16 years	7.2	13.7	13.5
Adults	9.15	16.5	14.4

TABLE2:INTERNAL DIMENSION OF THE TRACHEA(AFTER ENGLE-1962)

Bronchopulmonary Segments.

Various nomenclature have been proposed. Of those JACKSON AND HUBER (1943) has appeared to be the most useful and has been widely accepted. In this system the bronchopulmonary segments of the five lobes are named in accordance with their relative position in the lobe. (Figure 2 and 3).

Right Main Bronchus.

The right main bronchus is wider and more vertical than the left being more in continuity along the line of trachea. The right main bronchus extends from the tracheal bifurcation to the upper lobe orifice. The portion between the upper lobe orifice and the middle lobe orifice is referred to as "bronchus intermedius".

The right main bronchus is about 5cm in length.. Average angle made by the right main bronchus with trachea is 25 to 30 degrees. The coronal diameter of right main

bronchus is about 17 plus or minus 4mm in men and about 15 plus or minus 4mm in women; the corresponding diameter on left side is 2 to 3mm less.

The Right Upper Lobe Bronchus(RUL)

It arises around 12 to 20mm from the carina on the lateral aspect of the right main bronchus. It travels in a lateral and somewhat upward direction for a very short distance, almost at right angles to the line of the main bronchus. It measures around 10mm in length. It is divided into three nearly equal-sized segmental divisions. The anterior, apical, and posterior divisions of the upper lobe are supplied by these three divisions.

Right lung	Left Lung
Right Upper Lobe (RUL) -Apical Segment (1) -Posterior Segment (2) -Anterior Segment (3)	Left Upper Lobe (LUL) -Apico-posterior Segment (1+2) -Anterior Segment (3)
Right Middle Lobe (RML) -Lateral Segment (4) -Medial Segment (5)	Lingula(LML) -Superior Segment (4) -Inferior Segment (5)
Right Lower Lobe (RLL) -Apical Segment (6) -Medial Basal Segment (7) -Anterior Basal Segment (8) -Lateral Basal Segment (9) -Posterior Basal Segment (10)	Left Lower Lobe (LLL) -Apical Segment (6) -Medial Segment (7) -Anterior Basal Segment (8) -Lateral Basal Segment (9) -Posterior Basal Segment (10)

TABLE-3: BRONCHOPULMONARY SEGMENTS

The Right middle lobe bronchus (RML)

The right middle lobe bronchus originates 2.5 to 3 cm beyond the upper lobe orifice and represents the definitive end of the right main bronchus, or bronchus intermedius in alternate terminology. It arises from the anterior aspect of the main bronchus and runs forwards, downwards, and somewhat laterally, almost parallel to the lower part of the lung's oblique fissure. After a short course of 2cm the middle lobe bronchus divides into

(4) Lateral Segment

(5) Medial Segment

The Right lower lobe bronchus (RLL)

The right lower lobe bronchus is the continuation of the principle stem beyond the origin of the middle lobe bronchus . It supplies 5 segments of the lung.

(6) Apical Segment:

It arises from the posterior aspect of the termination of the right main bronchus. Its orifice is opposite to and only a short distance lower than that of the right middle lobe bronchus. It subsequently divides into medial, superior and lateral branches, the former two usually arising from a common stem.

In terminology of nomenclature the British call it as "Apical Segment" and the American's call it as "Superior Segment". In over 50% of Right lungs a Sub apical (sub superior) segmental bronchus arises from the posterior surface of the right lower lobe bronchus between 1 and 3 cms below the apical (superior) segmental bronchus. This is distributed to the region of lung between the apical, and posterior basal segment. The right lower lobe bronchus distal to the apical (superior) segment is referred to as basal bronchus.

There are four basal segmental bronchi in the right lower lobe.

(7) Medial Basal segment :

It has a higher point of origin than the other basal segmental bronchi. It runs parallel to the right border of the heart inferomedially, hence often referred to as cardiac segment.

(8) Anterior Basal Segment:

It descends anteriorly.

(9) Lateral Basal Segment

(10) Posterior Basal Segment

The left main bronchus

The left main bronchus is about 5.5cm long and is narrower than the right main bronchus because it supplies a smaller lung. It forms a 45° angle with the trachea. It then goes laterally and downwards beneath the arch of aorta, into the left lung's hilum. The bronchus crosses anterior to the oesophagus, thoracic duct, and descending aorta. The left pulmonary artery lies at first anterior and then superior to it. It enters the hilum of the lung at the 6th thoracic vertebra and divides into upper and lower lobe bronchus.

The left upper lobe bronchus (LUL)

About 5.5 cm from the carina, the left upper lobe bronchus arises from the anterolateral aspect of the parent bronchus. It curves laterally for a short distance before dividing into two bronchi/divisions, cranial and caudal, which correspond to the right lung's upper and middle lobe bronchus. They are both distributed to the left lung's apical (superior) lobe, which lacks a separate middle lobe. , The cranial division ascends for about 10mm before giving off

(3) Anterior segmental bronchus

It then continues for another 1cm upwards, forming the (1+2) Apicoposterior segment, which finally divides into Apical and Posterior branches.

The caudal division descends anterolaterally to be distributed to the anteroinferior part of the superior lobe of the left lung This part of the lung is called "lingula" because of its structural resemblance to tongue (i.e. thin and long. segment). The lingular bronchus divides into two segments.

(4)Superior segment.

(5) Inferior segment.

The left lower lobe bronchus (LLB).

The left lower lobe bronchus follows the same division patterns as on the right side like a mirror image. The left lower lobe is smaller than the Right lower lobe.

(6) The Apical segment

It takes origin from the posterior aspect of the left lower lobe bronchus below 1cm from the upper lobe orifice. Its about 0.5 to 1 cm in length and divides into medial and superolateral trunks.

The inferior lobe bronchus continues further 1 to 2 cm before dividing into two main stems.

-Anteromedial and Posterolateral stem,

The antero medial stem runs anteriorly and medially and terminates as

(7) Medial Basal Segment &

(8) Anterior Basal Segment.

The posterolateral stem terminates as

(9) Lateral Basal Segment. &

(10) Posterior Basal Segment.

There has not always been recognition of the medial basal segmental bronchus on the left side because of its common origin with the anterior basal segment. However in 10% of lungs it arises independently from the lower lobe bronchus and in all cases it supplies a territory similar to its opposite number on the right side.

A subapical (sub superior) segmental bronchus arises from the posterior surface of the left lower lobe bronchus in as many as 30% of lungs.

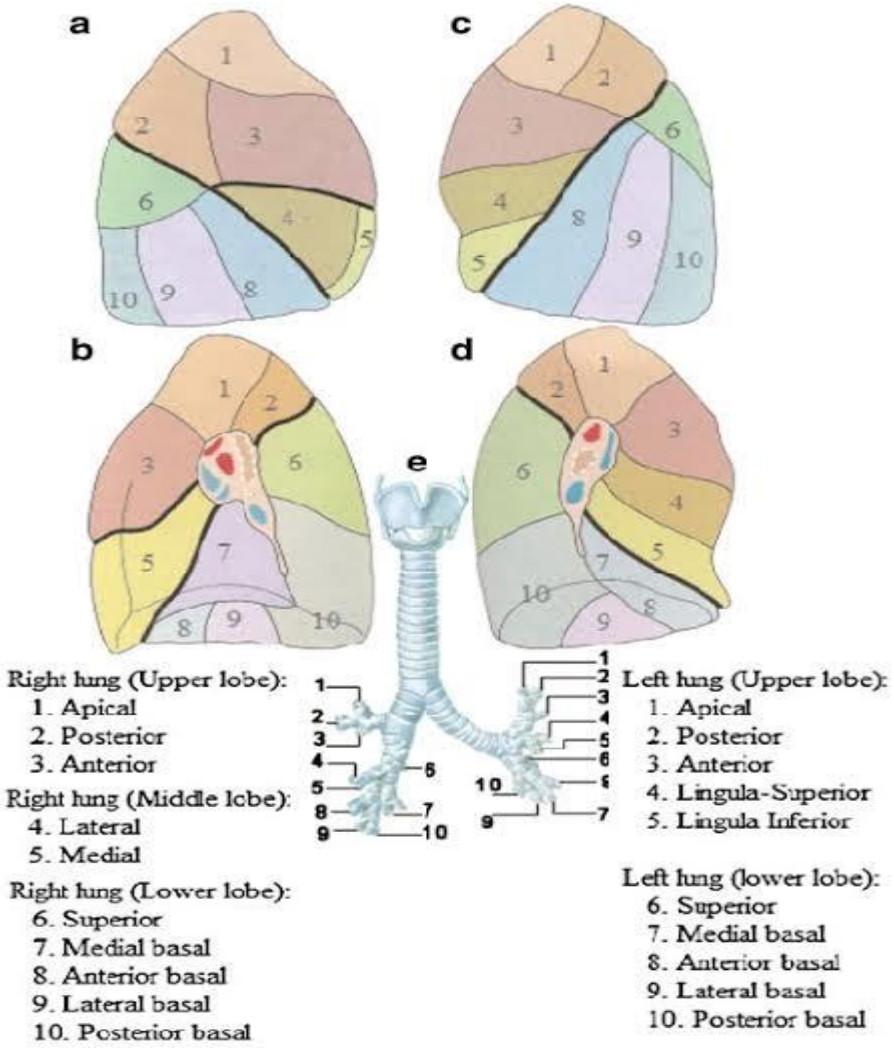

FIG:3 BRONCHOPULMONARY SEGMENTS

SUBSEGMENTAL BRONCHIAL NOMENCLATURE

For nomenclature of 4th or 5th order bronchi the subscripts i, ii and α , β respectively are added to the respective a or b classification. This (Figure 4) was proposed by Bronchial Nomenclature Committee 1970.

Bronchial Nomenclature Committee - 1970

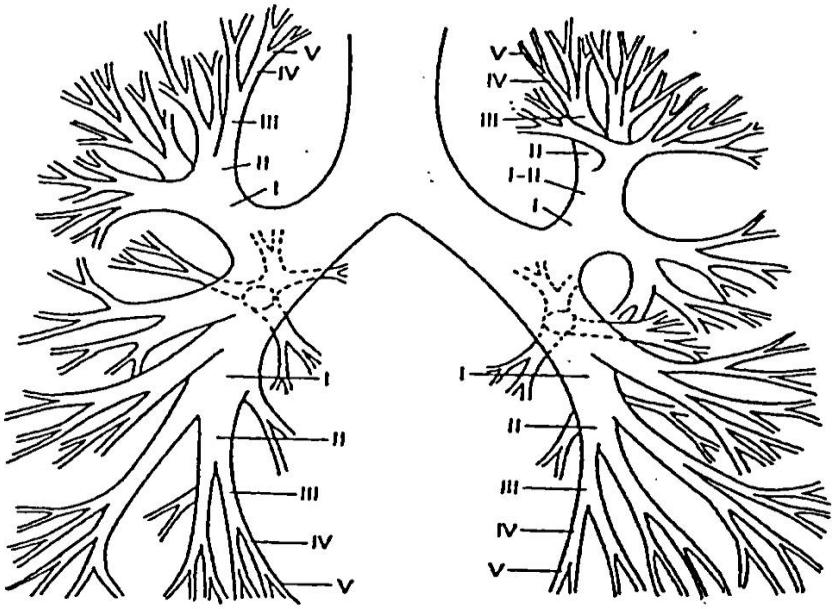

Fig. 4
Sub-segmental bronchi

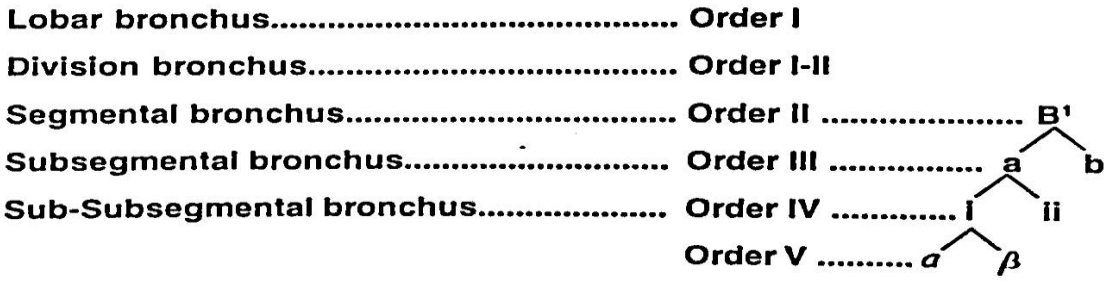

FIG-4 SUB SEGMENTAL BRONCHI

GROSS ANATOMY OF THE BRONCHUS

The bronchus can be divided in to two large categories

-The extra pulmonary bronchus

-The intra pulmonary bronchus

EXTRA PULMONARY BRONCHUS

The trachea, left and right main bronchi and truncus intermedius are referred to as extra pulmonary bronchii. They have horse shoe shaped cartilage crescent, varying in number according to the individual bronchi.

Generally in trachea 16 to 20, in left main bronchus 9 to 12, in right main bronchus 6 to 8 and in bronchus intermedius 4 to 6 cartilage crescents are present. In the trachea the cartilage crescents extend around two third, to four fifth's of the circumference, as oppose to half to two third in the main bronchus. The posterior wall of the bronchus, which is free of cartilage crescents and is referred to as the membranous portion, has a large amount of smooth muscle. The elastic fibers in the entire circumference, reaches thickness of 8 μm in membranous portion forming longitudinal folds.

INTRA PULMONARY BRONCHUS

The main difference from the extra pulmonary bronchus is the disappearance of the cartilage crescents. The crescent diminish to intermittent plates of cartilage at the point of transition (i.e. in the left and right upper and lower lobe) from extra pulmonary bronchus to intra pulmonary bronchus. The elastic fibers layer between the mucosal epithelium and squamousa is gradually replaced by smooth muscle which extends in rings surrounding the entire circumference of the bronchus appearing as circular folds.

STRUCTURE OF TRACHEA AND MAJOR BRONCHI

The trachea and the extrapulmonary bronchi consists of a framework of incomplete rings of hyaline cartilage united by fibrous tissue and nonstriated muscle.

The cartilages :-The cartilages are incomplete rings which stiffen the wall of the trachea anteriorly and laterally. Behind, where the rings are deficient, the tube is flat and is completed by fibrous and elastic tissue and non-striated muscle fibers. The cartilages measure about 4 mm vertically and 1 mm in thickness They are placed horizontally one above the other and are separated by narrow intervals, two or more of the cartilages often unite, partially or completely and are sometimes bifurcated at their extremities. They are highly elastic but may become calcified in later life.

The first tracheal cartilage is broader than the rest and is sometimes blended with the cricoid cartilage to which it is connected by the cricotracheal ligament. The last tracheal cartilage is thick and broad in the middle where its lower border is prolonged in to a triangular process which curves downwards and backwards between the two bronchi forming a bridge called the carina. The C ring structure persists in the extra pulmonary portion of the bronchial tree where. the wall need's to be little rigid.

The Fibrous Membrane: Each of the cartilage is enclosed in perichondrium. This is continuous with a sheet of dense irregular connective tissue forming a fibrous membrane between adjacent rings of cartilage and at the posterior aspect of the trachea and extra pulmonary bronchi, where the cartilage is incomplete. It is mainly composed of collagen intermingled with some elastic fibers which cross each other diagonally allowing changes in diameter of the enclosed air way. Non striated muscle fibers are present within the fibrous membrane at the back of the tube. Most of these fibers are transverse and are inserted in to the perichondrium of the posterior extremities of the cartilage (in the trachea they are known as Trachealis muscle.) Contraction of these fibers, therefore alters the cross sectional area of the trachea or

bronchi. A few longitudinal fibers lie external to the transverse fibers. The relative thickness of the muscle increases as the branching bronchi become narrower.

The Mucous Membrane: The mucous is continous with and similar to larynx. It consists of a layer of pseudostratified ciliated columnar epithelium with numerous goblet cells resting on the broad basement membrane. The cilia beat the over lying layer of mucous upwards in the larynx and pharynx. Deep to the epithelium and its basement membrane are

1)Lamina Propria - Rich in longitudinal elastic fibers.

2)Sub Mucosa - Loose irregular connective tissue in which blood vessels, nerves, most of the tubular glands and patches of lymphoid tissues, are present.

3) Perichondrium and fibrous membrane lying deep to the sub mucosa.

THE STRUCTURE OF SMALLER BRONCHI

With increased branching of the segmental bronchi the epithelial lining becomes thinner and ultimately single layered. The cartilage plates become smaller and few. Circular muscle almost completely surrounds the tube inside the cartilage. The muscle fibers contain numerous elastic fibers and are arranged in an interlacing network, partly circular and partly diagonal so that their contractions constrict and shortens the tube.

Blood Supply :

Trachea - Its derived mainly form the branches of inferior thyroid arteries. The thoracic end of the trachea is supplied by bronchial arteries which anastomose with the inferior thyroid artery. The tracheal veins drain in to the thyroid venous plexus.

Bronchi- The bronchi from the carina to the respiratory bronchioles, lung tissue, visceral pleura and pulmonary nodes are all supplied by bronchial arteries. There are three bronchial arteries

One for the right lung and two for the left lung.The left bronchial artery usually arises from the anterior aspect of the descending thoracic aorta. Sometimes the right bronchial artery may arise from aorta, first Inter costal artery the internal mammary or the right sub clavian artery. The arteries lie against the posterior half of the respective bronchi.

Venous Drainage:

The bronchial veins form two distinct systems. The deep bronchial veins commence as a network in the intrapulmonary bronchioles and communicate freely with the pulmonary veins, they eventually join to form a single trunk which terminates in a main pulmonary vein or in the left atrium.

The superficial bronchial veins drain the extrapulmonary bronchioles. They terminate in the azygous vein on the right side, and in the left superior intercostal vein or the acessary (superior) hemi azygous veins on the left side.

Lymphatic Drainage :

The tracheal lymphatics drain into pretracheal group of nodes. The lung has an abundant lymphatic supply which exists as two systems. The superficial or pleural systems forms a plexus of lymphatics beneath the pleura and is provided with

numerous valves. These lymphatics with numerous valves, unite and drain into hilar lymph nodes. The deep or alveolar system accompanies the pulmonary and bronchial arteries and conveys the lymph from the interior of lung to the hilar lymph nodes.

There are pulmonary group of nodes around the smaller bronchi with bronchopulmonary nodes being mainly beneath the point of division of the intrapulmonary air passages. Inferior tracheobronchial nodes lie beneath the divisions of large bronchi, and a subcarinal group of nodes lie beneath the bifuraction of the trachea.

All these nodes subsequently drain to either the Right or Left paratracheal lymph nodes. The right superior tracheobronchial node drain the whole of the right lung and also has a communication with the left upper lobe. The left superior tracheobronchial node drains the greater part of the left lung.

The inferior tracheobronchial nodes (Subcarinal) is important in that these nodes drain lymph from both lungs and in turn drain to both right and left paratracheal nodes. Clinically if these nodes become enlarged, they will cause widening which should be visible on bronchoscopy.

Lymphatics from the Right and Left paratracheal lymph nodes unite with vessels from the right and left bronchomediastinal trunks which drain either into the right lymphatic duct and left thoracic duct respectively or independently into the junction of internal jugular vein of their own side.

Nerve Supply :

The muscle fibers of the trachea including trachealis muscle are innervated by the recurrent laryngeal nerve which also carries sensory fibers from the mucus membrane. Sympathetic nerve fibers are derived mainly from the middle cervical ganglion and have connections with recurrent laryngeal nerve.

The lungs are supplied by the anterior and posterior pulmonary plexus situated at the hilum of each lung. The parasympathetic fibers carried in the vagus are both efferent and afferent.

The vagal efferent fibres are bronchoconstrictors for the bronchial muscle and secretomotor and vasodilator to the bronchial mucus glands.

Afferent fibers are involved in cough reflex.

The efferent sympathetic fibers are postganglionic branches of the second to fifth thoracic ganglion with an occassional contribution from the stellate ganglion. They are dilator (inhibitory) to the bronchi and pulmonary arterioles. The afferent sympathetic fibers have their cells of origin in the ganglion on the posterior roots of the second to fifth thoracic spinal nerves.

ETIOLOGY OF FOREIGN BODY ASPIRATION

The causative factors may be classified as follows:

1) Personal factors

Age- 99% occurs in children, infants tend to explore the world with their mouth by putting every thing in mouth.

Sex, occupation (work/play) and place of residence are important personal factors.

2) Failure of the patient's normal protective mechanism, including sleep. epileptic seizures, unconciousness and, alcoholic incordination.

3) Physical Factors - Expression of emotions, activities, posture.

4) Dental- Medical and surgical factors.

5) Psycopathic and psychotic factors.

6) Properties of foreign bodies itself.

7) Carelessness in the form of:

a) putting inedible substances in mouth.

b) hasty eating and drinking.

c) permitting children to play while eating.

d) giving peanut candy to children in whom the molars have not yet erupted.

8) Socio economic factors - The high prevalence of foreign bodies is due to parental inattention, majority of them occurred in poor and low socio economic class. People who do not have sufficient knowledge to realise the dangers of foreign body aspiration and in whom younger children are looked after by older children.

9) Neurogenic - Depression of pharyngeal reflexes can occur in:

a) Coma

b) drugs - opiates/ alcohol consumption and subsequent muscular incordination can bring about foreign body aspiration. Similar things may happen after organophosporous poisoning, bromism, iodism.

c) Peripheral nerve palsy -IX Nerve palsy and superior laryngeal nerve palsy can cause mucosal anesthesia, hence aspiration.

d) Muscular incordination -causing partial closure glottis after partial laryngopharyngectomy may cause aspiration.

Failure of the relatively efficient protective mechanism or reflex: must be considered among the causes of foreign body in the larynx, trachea and bronchus. These reflexes are:

1) Laryngeal closing reflexes.

2)The bechic reflex.

Laryngeal closing for normal swallowing consists of chiefly in the tilting and the closure of the upper laryngeal orifice. The ventricular bands help, but slightly and the epiglottis and the vocal cords help little if at all. The gauntlet to be run by the foreign bodies entering the tracheobronchial tree is composed of

1) Epiglottis

2) Upper laryngeal orifice

3) Ventricular bands

4) Vocal cords.

5) Bechic blast

The epiglottis acts some what as a fender. The superior laryngeal aperture composed of a pair of movable ridges of tissue has almost a sphincteric action, in addition to the tilting movement. The ventricular bands can approximate under powerful stimuli. The vocal cords act similarly. The one defect in the efficiency of this barrier is produced by the impulse to take a deep inspiration preparatory to the cough excited by the contact of a foreign body.

PROPHYLAXIS OF EXOGENOUS FOREIGN BODY IN AIR PASSAGE

Most of the foreign body aspiration accidents are preventable. The main points to be followed are

1) If one puts into his mouth nothing but food, foreign body accidents would be rare. The habits of holdings tacks, pins and what not in the mouth is quite universal and deplorable. Children are prone to follow the bad example of their elders. No small objects such as safety pins, buttons, or coins should be left within a baby's reach. Children should be watched and taught not to place things in their mouth, mothers should be specially cautioned not to give nuts or nut candy of any kind to a child whose power of mastication are imperfect because the molar teeth are not erupted. It might be made a dictum that "no child under 3. years of age should be allowed to eat nut, unless ground finely as in peanut butter". Digital efforts at removal of foreign bodies frequently force the object forward into the larynx, whereas if the intruder is not meddled with digitally it may be spat out.

2) Prophylaxis of medical surgical and dental accident merits considerations. Before general anesthesia is administered mouth should be searched for loose teeth,

removable dentures etc and the mouth of every unconscious individual should be similarly examined.
Atrophy of alveolus renders dentures a bad fit which increases the risk of their being swallowed or aspirated.
When working in the mouth the operator/ surgeon should take precautions against the possible inhalation or swallowing of loose objects or instruments.

SITE OF LODGEMENT

The majority of foreign bodies in the deeper air passages occur in children. The right bronchus in thought to be more frequently invaded than the left because of the following reasons.

1)It's greater diameter.

2) It's lesser angle of deviation.

3) The situation of carina to the left of the middle of the trachea.

4) The action of trachealis muscle.

5) The greater volume of air going into the right bronchus on inspiration.

Foreign bodies that fill the lumen may be carried in suddenly to the site of lodgement. Foreign bodies of relative diameter do not go like a projectile to the site of lodgement but work downward, like a ratchet.

The middle lobe bronchus is rarely invaded by foreign body probably due to the fact that very few individuals lie prone which favours the foreign body. dropping forward by gravity.
Invasion of the upper lobe bronchi is favoured by posture especially in case of foreign bodies which are heavier at one end-eg: safety pins. When the heavy end or head reaches the upper lobe orifice and the patient lies on corresponding side, the heavy end or head by gravity drops in the orifice and moves towards the periphery by a ratchet like mechanism.

The site of lodgment of the foreign body is often only temporary, the tendency to shift being of utmost clinical importance. The new site may be even in the other lung or in the same lung working deeper, this is called Wandering Foreign Body.

Multiple foreign bodies they may be present in the same lung or other lung. A foreign body may reach the tracheobronchial tree by ulceration, from the esophagus into the trachea or into a bronchus usually the left, although ordinarily. its only the suppurative process that penetrates, the intruding foreign body remaining fixed in fibrous tissue in the esophagus.

FACTORS RESPONSIBLE FOR OVER LOOKING OF FOREIGN BODY IN AIRWAY

Foreign bodies had been regarded as curiosities of medicine rather than as diagnostic possibilities for routine exclusion.

Chief factors in overlooking of the foreign bodies are

1) Failure to consider the possibility of foreign body.

2) Failure to elicit the history.

3) Absence of a history of foreign body.

4) Skepticism as to the possibility of the presence of foreign body in some instances even in the face of a very positive circumstantial history of the accident.

5) Apathetic attitude of the practitioner.

6) The symptomless interval.

7) Multiplicity of the foreign bodies.

8) Waiting for spontaneous expulsion of the foreign body.

9)Simulation, in case of a foreign body, of the signs and symptoms of relatively common diseases as asthma, bronchitis, pneumonia, bronchopneumonia and empyema. encountering these common conditions daily, the practitioner does not feel called on to go out of his way to consider seemingly remote possibility like foreign body.
Until the practitioner deems it necessary to exclude foreign body in every case of acute or chronic pulmonary disease, foreign body in the lung will continue to be overlooked.

10)Lack of emphasis, in medical teaching, on exclusion of foreign body in every case of acute and chronic disease of the chest.

11)Groundless assumption that the foreign body has been passed by bowel.

12) Character of the foreign body.

PATHOPHYSIOLOGY OF FOREIGN BODY SPIRATION

Foreign body in the tracheo-bronchial tree is an accidental invasion or presence of foreign body/ substance in the tree. It may be solid or liquid in nature from animal, mineral and vegetable kingdom. It may be endogenous like pus, blood, secretions etc or exogenous which may be aspirated through natural passage or penetrated through chest wall, eg: bullet.

Aspiration of foreign body in tracheobronchial tree occurs mainly in children between 1 and 3 years of age. The natural tendency of an infant is to put anything in to his mouth. He doesn't expectorate an inedible object as an adult would, but tries to swallow it thereby converting it into a foreign body.

Dentition is not complete until the child is over 2 years of age and chewing habits are not fully established until 4 years of age. Nuts, raw vegetables or fruits require the grinding action of molars for thorough mastication. Consequently children under age of three should not be given food stuffs that have not been properly cooked or mashed. So there appears a dental factor involved in foreign body aspiration.

A foreign body which has entered the tracheobronchial tree will either settle down in one of the bronchi or it will remain in the trachea or settle down over the carina. Right main bronchus is the site of the bronchial foreign bodies.

As soon as the foreign body enter the tracheobronchial tree due to local irritation the patient gets a severe bout of cough and choking sensation. Due to reflex bronchospasm, patient develops cyanosis and even dysphagia is produced, probably due to reflex manifestation due to irritation. After sometime foreign body settles at

one place and acute symptoms usually subside. Since the children are unable to tell and parents also think that the foreign body has been coughed out, this may lead to serious complications and death may ensue. So an acute episode of cough and cyanosis should not be taken lightly. After this acute episode local and systemic changes will develop and depend on type size, site. duration of foreign body and to some extent on the age of the patient.

Foreign body in the bronchus may cause obstruction in many ways. The bronchoscope has revolutionised the concept of the pathologic mechanism of bronchial obstruction and visualisation of live moving bronchi revealed the fact that bronchial obstruction in the living is valvular and that the type of occlusion seen at autopsy is only one of three types of obstruction. (Fig. 5)

I)Partial Obstruction :

If a foreign body is small or there is sufficient space around it in the bronchus then the air will be allowed to pass during inspiration and expiration. There is only a partial obstruction to air passage, but the distal lung does not develop collapse or emphysema at this stage [(10)].

II) Check Valve :

This is the commonest mechanism. Usually a large foreign body occludes a bronchus, but air enters distal to the foreign body during inspiration as bronchi normally expands during this phase; but during expiratory phase bronchi contract hence air is not allowed to go out, causing trapping of air after every inspiration, leading to obstructive emphysema distal to the foreign body. The emphysema may cause mediastinal shift to opposite side especially during expiration and may cause cardiac tamponade.

III) <u>Stop valve :</u>

This occurs when a foreign body is large enough to occlude the bronchus completely or mucosal edema develops around the foreign body after sometime.

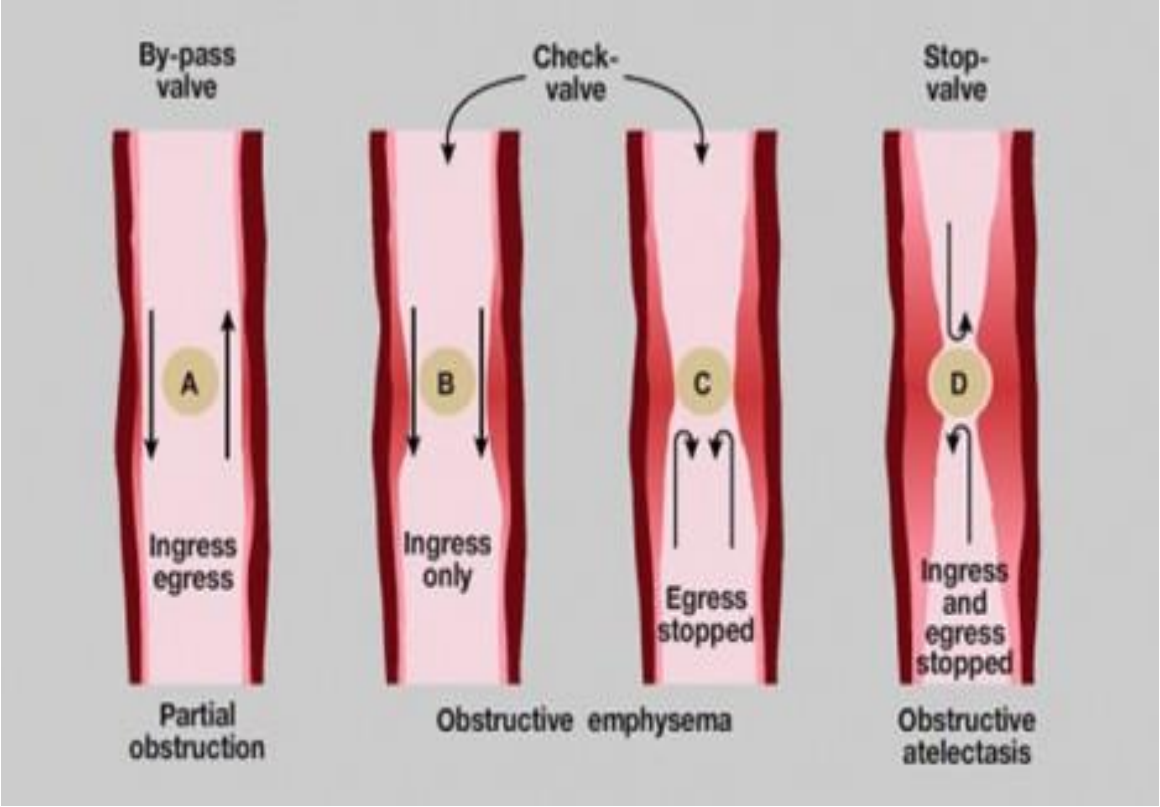

FIG: 5 MECHANISM OF BRONCHIAL OBSTRUCTION

This causes a total obstruction to air distal to the foreign body during inspiration also. After sometime the trapped air is absorbed and atelectasis of the lung distal to foreign body develops.

Vegetable foreign bodies like peanut, seeds etc produce severe tracheobronchitis also known as arachidic bronchitis or peanut bronchitis. This occurs due to presence of fatty acids in the nuts. They being hygroscopic in nature absorb water from surrounding mucosa and swell up causing an easily total occlusion of bronchus and

collapse. All these produce an early severe pneumonitis. So signs and symptoms develop early in vegetable foreign bodies.

On the other hand non vegetative foreign bodies remain asymptomatic for a long time and are well tolerated by the patients because

I) If flat or hollow in shape enough space is left around or through the foreign body for adequate air entry distal to it.

II) They usually have smooth non-traumatising edges or borders so that local trauma or edema of bronchial mucosa does not develop easily.

The atelectatic lung loses its function of ventilation and gaseous exchange. The unobstructed part develops compensatory emphysema. Respiratory efficiency of emphysematous lung is also greatly reduced.

The atelectatic lung develops pneumonitis, if untreated, patient develops. toxaemia. If patient survives, complication like bronchiectasis, lung abcess, fibrothorax may develop.

CLINICAL FEATURES / SIGNS AND SYMPTOMS

The signs and symptoms of foreign body aspiration are quite diverse and often very non specific. In most instances, patients are able to relate a history of foreign body accident, but many are unable to give such information due to their young age. Foreign body accidents usually involve three distinct stages. [32]

Stage-I This event is characterised by an episode of coughing, gagging, choking and occasionally airway obstruction. In many patients, a history of such an event can be elicited. It is not uncommon however for young children or elderly adults with mental changes who are prone to such accidents to be incapable of giving a history and initial event having gone unnoticed by family care takers. Older children are often reluctant to divulge the details of the accident due to embarrassment or the fear of punishment. Frequently parents of toddlers minimise a distant episode of coughing and gagging and do not include it in the history, making it imperative that the physician specifically enquires as to such an event.

Stage - II Following the initial event, the patient typically experiences an asymptomatic interval. In this stage the reflexes accounting for symptoms of initial event are fatigued. It is this stage that leads to the frequent delay in diagnosis of several days to months.

Stage-III The final stage of foreign body accident is characterised by complications of the event due to obstructions, erosion or infection. These may be as non specific as failure to thrive, wheezing, fever, malaise or dysphagia. Its unfortunate that serious complications such as recurrent pneumonia, atelectasis, lung or mediastinal

abcess or massive hemorrhage due to a vascular fistula may occur before a thorough investigation is launched, revealing the presence of foreign body.

The characteristic features of laryngeal foreign body include hoarseness. or aphonia, dyspnoea and stridor. Laryngeal obstruction is recognised by occurrence of retraction of suprasternal, supraclavicular and intercostal spaces.

The incidence of foreign body in the trachea is approximately one-sixth that of foreign body in the bronchus. A foreign body small enough to pass through the sub-glottic lumen would not be expected to obstruct the tracheal lumen to a dangerous degree. However foreign bodies capable of increasing in size with absorption of moisture (eg: a bean) may be responsible for rapidly increasing dyspnoea and possible asphyxia.

The initial episode of choking, coughing, wheezing and dyspnoea may be followed by an asymptomatic interval when child breathes in a gaurded manner Three features described by Jackson and Jackson[32] which can be noticed on examination are

1) Audible slap which is best heard at open mouth during a cough.

2) The palpatory thud.

3) Asthamatoid wheeze heard with the ear at the patient open mouth

In bronchial foreign bodies initial symptoms of are coughing, choking and asthmatiod wheeze. At once, or after a symptomless interval, cough, blood streaked sputum, metallic taste, or special odour of foreign bodies may be noted. Non obstructive metallic foreign bodies afford few symptoms and few signs for weeks or months. Obstructive foreign bodies cause atelectasis, drowned lung and eventually pulmonary abcess. Organic foreign bodies of vegetable origin such as peanut kernels, beans and water melon seeds, at once cause laryngotracheobronchitis with toxemia, cough and irregular fever. Organic foreign bodies such as bones or animal shells after months or years produces changes which causes chills, fever, sweats,

emaciation, clubbed finger, incurved nails, cough, foul expectoration and hemoptysis.

The physical signs vary with conditions present in different patients and at different times in the same patient.; The foreign body may change position, admitting more, less or no air, or it may shift to a new location in the same lung or even in the other lung. The signs of diagnostic importance are chiefly those of partial or complete bronchial obstruction, although a non obstructive foreign body, a pin for instance may cause limited expansion on the invaded side. The characteristic physical signs are;

1. Limited expansion
2 Decreased vocal fremitus
3. Impaired percussion note.
4 Diminished intensity of the breath sound distal to the foreign body.

Complete obstruction of the bronchus followed by drowned lung added absence of vocal resonance and vocal fremitus, and rales are usually most. intense on uninvaded side; in partial obstruction they are most often found on the Invaded side distal to the foreign body, especially posteriorly and are most intense at the site corresponding to that of the foreign body.

A foreign body at the bifurcation of the trachea may give signs in both lungs. Early in a case of a foreign body, diminished expansion of one side, with dullness may suggest pneumonia in the affected side; but absence of, or decrease in vocal resonance, and absence of typical tubular breathing should soon exclude this diagnosis.

X-RAYS

X-ray examination of the patient must be performed and should include all the structures from the nasopharynx to the ischial tuberosities, otherwise a foreign body may be overlooked. X-rays of the neck should be taken with neck extended position with anteroposterior and lateral views.

X-ray chest P/A view at the end of deep expiration and inspiration should be taken, although these views are sometimes difficult to obtain in very young children [(2)].A lateral chest X-ray completes the examination.

The time interval between inhalation and abnormal radiological findings was noted by Baraka (1974) [(21)] and he found no X-ray evidence of a foreign body within 24 hrs of inhalation in his pediatric practice this figure altered dramatically after 24 hrs when abnormal X-rays were noted in 90% of the patients.

A useful roentgenographic sign that is helpful in determining the presence of obstruction of one of the larger bronchi is that of HOLZKNECHT SIGN(1899) [(17)]. This consists of an inspiratory retraction of the mediastinum towards the affected hemithorax.

COMMONLY SEEN X-RAY FINDINGS IN FOREIGN BODY ASPIRATION:

1) **Obstructive emphysema. FIG-6**

Its produced by a valvular obstruction to the expiratory air stream due to the presence of a foreign body in the lumen of the air passage. The action of valve is due to the fact that the air passages dilate on inspiration and contract on expiration. Thus on each respiratory cycle, a small amount of air is trapped beyond the obstruction and the lung is literally pumped up with air during each phase of the respiratory cycle. There will be mediastinal shift during expiration to the unobstructed side of the chest, in inspiration the mediastinum may be in the midline.

2) **Atelectasis (Collapse).** FIG-7

It occurs on stop valve type of respiratory air flow obstruction i.e. no ingress/ egress of air occurs from beyond the foreign body. The mediastinum shift towards the obstructed side of the chest both in expiration and inspiration.

The atelectasis may be of whole lung or part of lung i.e. involving a lobe or a bronchopulmonary segment.

3) **Foreign body Visualisation :**

Radio opaque foreign bodies in the tracheobronchial tree can be easily recognised.

4) **Pneumonitic Changes :FIG-8**

It may be seen effecting single lobe or bronchopulmonary segment or even diffuse pneumonitis can be seen.

5) **Normal :**

Most of the X-rays do not show any of the abnormity. It takes 24 to 48 hours for radiological changes to be seen in the X-ray after foreign body aspiration.

6) **Mediastinal Emphysema** :

Screening may also help; but standard X-rays are usually sufficient. Computerised tomographic studies may help to show a foreign body not seen with conventional studies. Isotope scans will demonstrate changes in ventilation and perfusion of lung tissues. These sophisticated radiographic techniques are rarely necessary in obvious cases of inhaled foreign bodies. They should not be ordered if they delay the definitive endoscopic assessment of the patient.

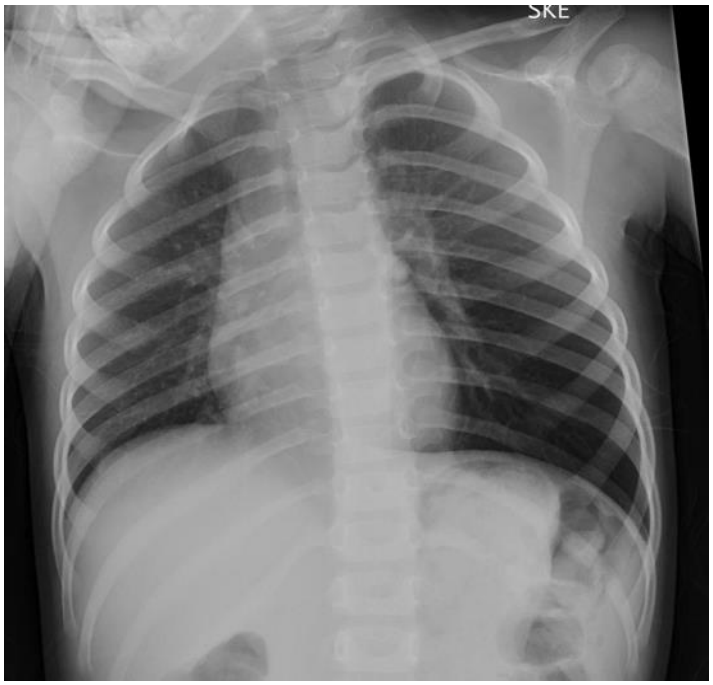

FIG-6: OBSTRUCTIVE EMPHYSEMA

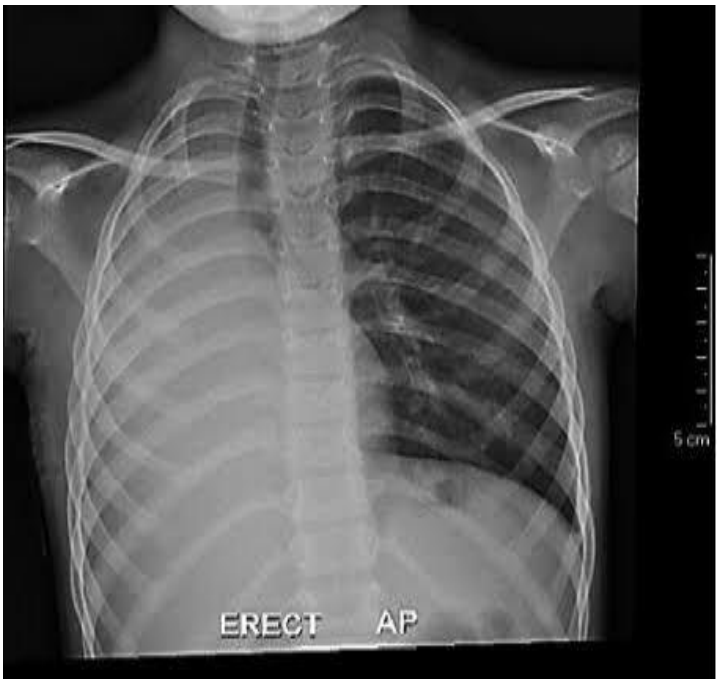

FIG-7: LUNG COLLAPSE

FIG-8: PATCHY PNEUMONITIS

ANESTHESIA

The anesthetic management of the pediatric patient with airway disease is a unique challenge that involves a detailed understanding of the anatomy and physiology, and of the interaction of positive pressure ventilation; the relaxation of airway structures from anesthesia and anesthetic pharmacology. However the most important element of success is close communication between the endoscopist and the anesthesiologist and close working relationship must be developed to plan patient management and to continuously monitor and modify activities as the case proceeds.

PREMEDICATION :

Premedication has two roles, vagolysis and anxiolysis. Atropine or another belladona drug is useful in children younger than 1 year of age because of its drying actions and vagolytic activities. Sedation in children and adolescents relieves anxiety and decreases hypertensive response.

However, if patient has airway obstruction or obstruction in sleep, sedative premedication is not used.

ANAESTHETIC EQUIPMENT :

An assortment of masks, airways, endotracheal tubes and drugs are kept readily available.Standard monitoring including a stethoscope, pulse oximeter, electrocardiogram, blood pressure device and capnograph is established before induction with temperature monitoring started after induction. The audible tone of the pulse oximeter changes with progressive decrease in saturation permitting detection of hypoxemia and capnograph detects exhaled carbondioxide.

ANAESTHETIC AGENTS

Volatile agents and gases:

Volatile agents include halothane, enflurane, isoflurane, sevoflurane & desflurane. Halothane and Nitrous Oxide are most commonly used.

Intravenous Agents :

A variety of I.V. agents can be used to induce and maintain anesthesia, including thiopental, ketamine, etomidate, propofol and narcotics, in conjunction with muscle relaxant like succinylchloline. IV agents have the advantage of fast induction and allows ventilation of patient with oxygen or air, removing the need to scavange waste gas.

ANAESTHETIC TECHNIQUES -

There are four anesthetic techniques for endoscopic procedures.

1)*Apnoeic Technique :* -

It's the simplest of techniques used for diagnostic procedures in the airway. After establishing G.A a muscle relaxant is given. The anesthesiologist removes the mask and allows the endoscopist to proceed without ventilation. The endoscopist has a clear unobstructed field of view, there is no movement.

Progressive hypercarbia and hypoxemia limit operating time and are influenced by the general condition of patient. To maximise operating time patient is hyperventilated first with 100% oxygen. The oxygen saturation measured by the pulse oximeter usually stays in the range of 99 to 100% for several minutes; and when it begins to fall the range of 96% to 97% effective ventilation and oxygenation is reinstalled. During this period the endoscopic procedure is periodically interupted.

2. *Intubation Of The Airway:*

If the endoscopist in going to work entirely through a rigid bronchoscope, the anesthetic circuit is coupled to the ventilation bronchoscope to provide ventilation through the side channel. The use of small bronchoscope, or a telescope within the ventilating scope may necessitate aggressive assistance or control of ventilation because of increased resistance.

3. *Jet Ventilation*:

It uses a supraglottic or tracheal jet or through the bronchoscope. The patient is anaesthetised with intravenous agents and muscle relaxant given with maintenance of airway. Alternatively, a mask induction is carried out with spontaneous ventilation. In the supraglottic technique a rigid metal jet injector is attached to the laryngoscope and positioned to allow clear path through the glottis. In the tracheal technique, a flexible catheter is passed between the vocal folds. Intermittent jets of gas are introduced.

The main advantage of this technique is endoscopic access. Disadvantages include the potential for tension pneumothorax, driving debris into the trachea and intermittent movement and alleged CO_2 retention. Although widely used, this technique does require experience to be practiced safely and effectively.

4. *Insufflation* :

It provides an unobstructed view of entire larynx and can be used for prolonged period. Here, a suction catheter of endotracheal tube is placed in the nasopharynx, advanced to the uvula under direct vision and securely taped in place.

The catheter is attached to fresh gas supply usually containing halothane and oxygen administered at a rate of 4 to 6 liters/minute.

It has several disadvantages. If patient is deeply anesthesized, hypoventilation occurs and if anesthesia is too light, breath holding and laryngospasm results.

COMPLICATIONS:

Most complications during surgery are related to the underlying lesion and the procedure. Unexpected hypoxemia can be caused by prolonged bronchoscopy, (especially with the tip in distal bronchi) secretions or blood in airway, bronchospasm and decreased cardiac output.

The most common complication is laryngospasm which is usually due to manipulation of airway under light plane of anesthesia.

Treatment Of Laryngospasm:

1.Jaw thrust and suction of secretions

2.100% oxygen inhalation.

3.If airway not restored Succinyl choline 0.5 to 1 mg/ kg i.v.

4.If i.v. line not in place Succinyl choline 2-3mg per kg IM.

5. An endotracheal tube or bronchoscope is passed if necessary.

6.If recurrent laryngospasm occurs, laryngoscopy for suctioning of blood, secretions or other material.

If bronchospasm develops, during the procedure, the initial responses are to remove any obstructing secretions, increase the level of volatile anesthetic and administer a B_2-agonist such as Albuterol, through the bronchoscope or ET tube. If deterioration persists i.v. aminophyllin can be given.

A rare but important cause of intra operative adverse events is malignant hyperthermia. This genetic condition presents as a hyper metabolic crisis usually triggered by certain drugs (Sch, volatile anesthetic agents) i.v. Dantrolene is given 2.5 mg/kg i.v.

POSTANESTHETIC MANAGEMENT:

The most common post anesthetic complication is hypoventilation due to residual anesthesia or airway obstruction.

Airway obstruction can result from the underlying pathological anatomy, edema from manipulation, blood or secretions or postintubation croup. The initial therapy is humidified oxygen by face mask. Nebulised recemic epinephrine (0.5ml of 2.25% epinephrine in 2.5ml of saline) is administered by face mask.
Corticosteroid like Dexamethasone is also used.

INSTRUMENTATION AND EQUIPMENT

An adequate set up with all necessary instruments is essential for the endoscopist, especially when dealing with challenging problems of foreign body extraction.

FLEXIBLE BRONCHOSCOPE : (FIG-9)

Several flexible bronchoscopes and an array of accessories are available for use by the pediatric bronchoscopist. Flexible bronchoscopes range in outer diameter (O.D) from 2.2 to 6.3 mm. The instruments most applicable to pediatrics are an ultra slim 2.2mm diameter instrument with distal flexion but no channel. and a 3.4 to 3.6 mm diameter instruments with a 12 mm channel. In older children or teenagers, an adult size bronchoscope (4.9mm to 5.0 mm OD) may be used.

Modern fiber optic bundles are composed of thousands of glass fibers, each of which is 8µm in diameter. These fiber bundles run from the tip of the bronchoscope to the eye piece and transmits the image of the airway to the operator or camera. A separate channel for suction, injection and instrumentation runs from the tip of the bronchoscope to the control head. For protection of fiber bundles, channel and cables are enclosed in a woven flexible metal sheet which in turn is enclosed in a plastic membrane making the instrument immersible Extending from the side of the control head is a light guide that carries light for illumination of the airway from the light source to the control head.

OTHER ENDOSCOPIC EQUIPMENT:

Light Source:

The halogen light sources available in most operating rooms provide bright illumination from a 250 watt halogen lamp.

Light Cables:

Fiber bundles are used to carry illumination from light source to the instrument. These cables use approximately 13% of their illumination per feet in length. Liquid light cables are more efficient and deliver more light to the instrument than the fiber bundles.

FIG-9: FLEXIBLE BRONCHOSCOPE

A: Eye piece

B- Light guide cable

C- Insertion tube

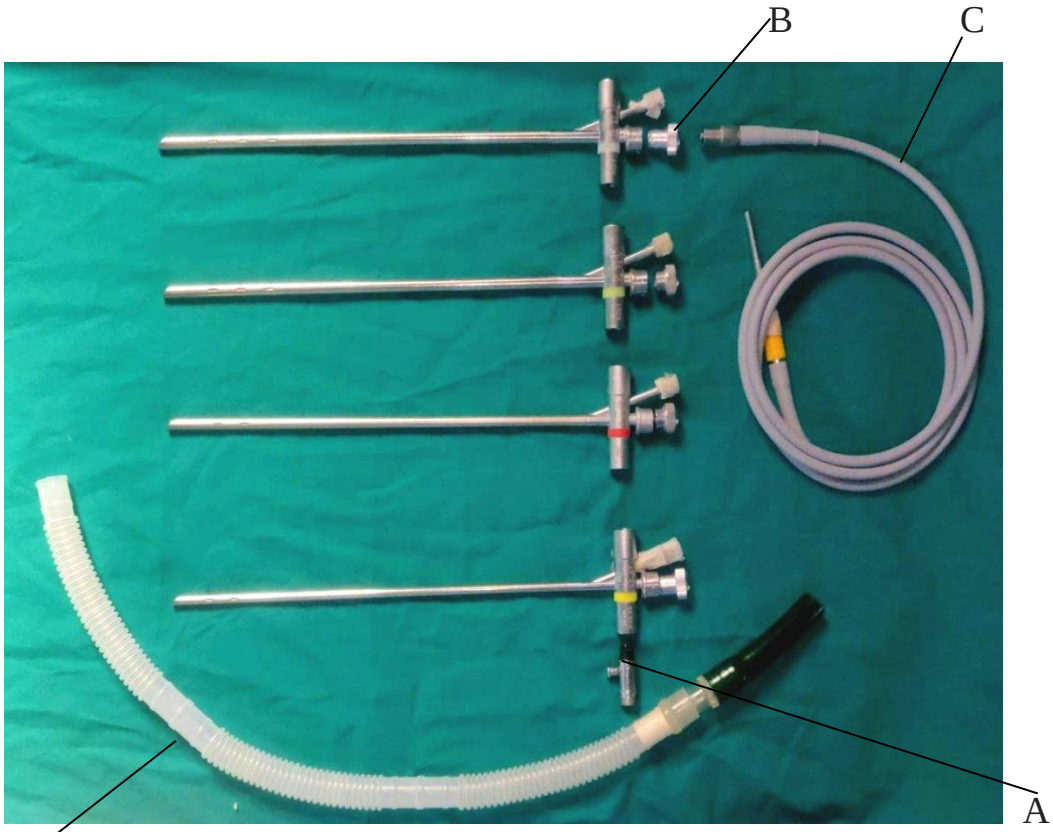

FIG-10: RIGID BRONCHOSCOPE

A: Prismatic light deflector

B: Window plug

C: Fibreoptic cable

D: Anesthetic adaptor

LARYNGOSCOPE:

The standard Jackson laryngoscope is designed with a flared tip for placement in the vallecula to give the surgeon a panoramic view of larynx and pharynx. The instrument may be used for general diagnostic purposes or for introduction of the bronchoscope or endotracheal tube.

RIGID BRONCHOSCOPE: FIG-10

They are rigid, straight, hollow metallic tube made of stainless steel. Rigid bronchoscopes are available in a range of sizes from 2.5 mm (3.7mm outer diameter [O.D]: Doesel-Huzly, Karl-Storz) to 9 mm (10mm O.D). Different sizes of rigid bronchoscopes are used according to the age of the patient.

TABLE-4: GUIDELINES FOR SELECTION OF BRONCHOSCOPE BY AGE

SL.NO	**Patient age :Mean (Range)**	**Bronchoscope (Storz) Size**	
		I.D in mm	**O.D in mm**
1	Premture infant	2.5	3.7
2	Term new born (new born to 3 months)	3	5.8
3	6 months (3-18 months)	3.5	5.7
4	18 months (1-3 years)	3.7	6.3
5	3 years (2-6 years)	4	6.7
6	7 years (5-10 years)	5	7.8
7	10 years (> 10 years to adolescence)	6	8.2

When the correct size is uncertain, a small tube should be used first.

Bronchoscope lengths vary from 20 to 40 cms permitting diagnostic and therapeutic procedures in the tracheobronchial tree. The tube protects the airway and allows the administration of oxygen and anesthetic gases through the closed system. On the proximal end is a standard 15mm adapter for anesthesia.

The Holinger bronchoscopes have a fiber bundle light carrier and a distal illumination, where as the pediatric Doesel-Huzly (Karl Storz) slopes have proximal illumination by a prismatic light deflector.(Fig-10)

The latter scopes have a working channel for fine forceps or suction catheters which can be used for telescopic observations. Telescopes can be used through both. All bronchoscopes can be used with a wide variety of foreign body and biopsy forceps. There are mainly two types of bronchoscopes i.e. Jackson and Negus. The proximal 1/3 of Negus bronchoscope is expanded which affords more room for inspiration and introduction of instruments.

Some of the bronchoscopes have bevelled distal extremity which facilitates mobilisation of epiglottis during intubation. Although some bronchoscopes are almost oval, most are round.

Some of the bronchoscopes have distal side ports that allow ventilation of the contralateral lung while working within an ipsilateral main bronchus Therefore rigid bronchoscopes can be referred to as ventilating or nonventilating based on the presence or absence of distal side ports. Nonventilating tubes are used primarily in the trachea.

The major manufacturers of rigid bronchoscope include EFER Company (La Ciotat, France) the Richard Wolf Company (Germany) and Karl -Storz Company (Germany).

HOPKIN's Telescopes are precision optical instruments that contain a series of glass-rod lens interspersed with air spaces for image transmission. The lenses are enclosed in a metal sheath and produce a magnified image with a good depth of field, wide angle view and little distortion. Diameters range from 1.7 mm to 10mm for use in a wide variety of endoscopic instruments. Straight forward (0°) telescopes are standard, but 30° 70° and 120° telescopes are available for a variety of applications (ie. Larynx, Trachea, Bronchi, Esophagus, Nasopharynx and Nasal passages). Each

telescope is matched to the bronchoscope by length so that tip of the telescope does not extend past the tip of the bronchoscope tube. Most systems use a bridge that fixes the telescope's position within the tube.

FORCEPS: (FIG-11)

Passive action forceps originally were designed by Chevalier Jackson. The blades open passively and are closed by the advance of cannula over the blades. More than 60 various foreign body forceps have been divised to cope with many mechanical problems of foreign body extraction.

Positive action (center action) forceps are designed for closing and opening of the blades by direct mechanical action through the handles. Optical forceps couple the rod-length telescopes with positive action forceps, improving visualisation of the forceps but compromising important tactile feedback.

The forward grasping forceps is the most often used for foreign body, but a light weight fenesterated forceps is especially useful, in case of, vegetable foreign body in children. The Tucker tack and pin forceps is most practical for use in extraction of slender, sharp, pointed object such as pins, tacks or nails The ball forceps is used for globular objects.(Fig-11)

SUCTION CATHETERS: (**FIG-11**)

They are necessary for the removal of the secretions from the tracheobronchial tree for diagnosis and treatment. They are connected to electrically operated negative pressure pump by rubber tubes. Collection systems for aspirate is also maintained.

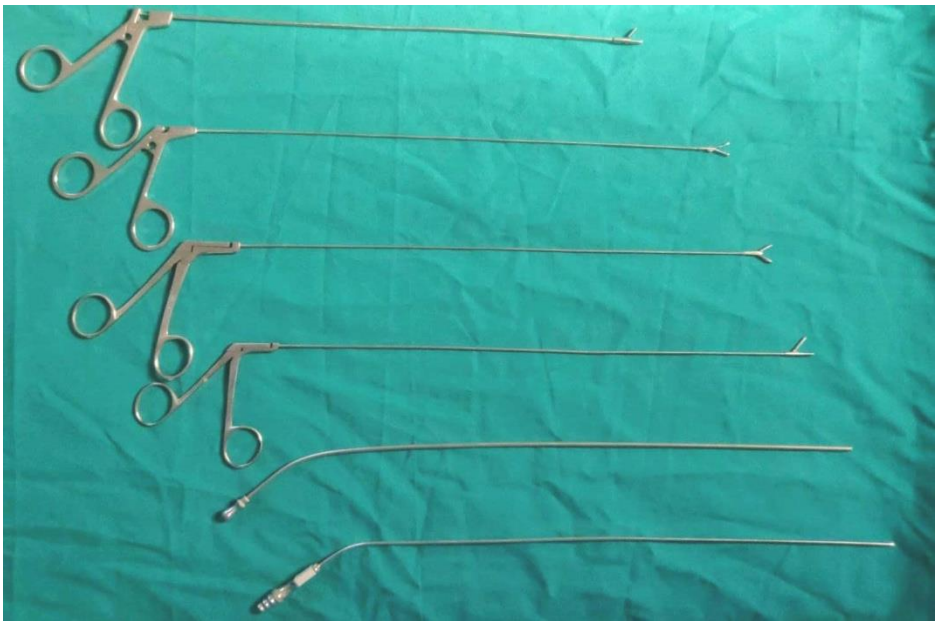

FIG-11: FORCEPS WITH SUCTION CATHETERS

VIDEO, STILL PHOTOGRAPHY:

Video monitoring is used most commonly and is adaptable to the operating microscope and any telescope. The small cameras now available add little weight to the entire endoscopic system. They have high resolution and low light sensitivity, providing the attending surgeon, residents, aneasthetists and nursing staff an excellent view and with anticipation to needs and problems of the procedure. A video recorder can be used for permanent documentation and a hard copy printer may be introduced to produce images for the medical record.

Photography is carried out with a 35mm single lens reflex camera adapted to a rod lens telescope illuminated by a synchronised automatic exposure electronic flash generator.

FIG-12: TECHNIQUE OF FLEXIBLE BRONCHOSCOPY

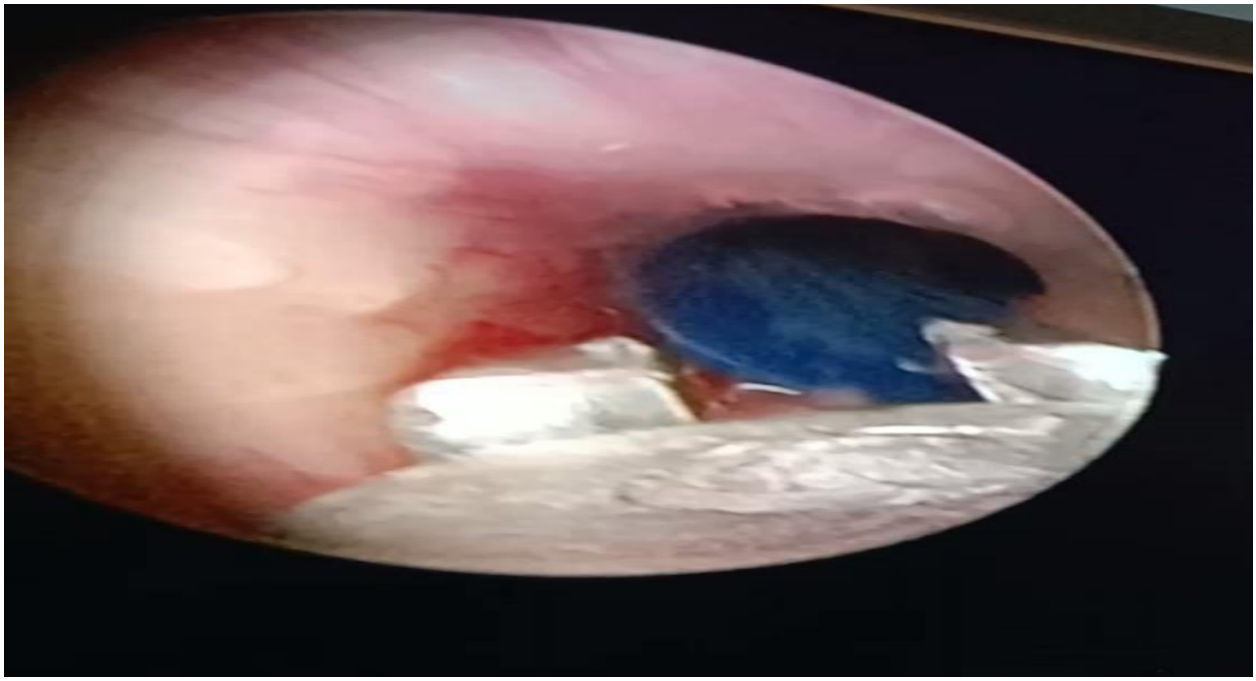

FIG-13: PLASTIC PEN TIP IN LEFT MAIN BRONCHUS

TECHNIQUE OF LARYNGOSCOPY

POSITION OF PATIENT

Direct laryngoscopy is done preferably in dorsal recumbant position as it affords better control. The head must be held high 15 cms above the level of table with slight extension.

The assistants left hand with thumb and fingers are on occiput and support the head and make extension. The left elbow rests on the left knee for support. The right arm support head or neck; it passes under the neck so that the right index finger holds the bite block between the patients teeth. The left foot rests over the foot rests and the right one on the floor under the table. The nurse holds the patients shoulder and keeps them on the table.

INTRODUCTION OF THE LARYNGOSCOPE

The following three steps are descriptive of the standard technique of introduction of the laryngoscope.

Step 1: With his right hand first and second finger the operator retracts the patients upper lip.

Step-II:- The spatular end of the laryngoscope is introduced in to the right side of the patients mouth, along the right side of the anterior two thirds of the tongue When the posterior third of the tongue is reached the tip of laryngoscope is directed towards the mid line and the dorsum of the tongue is elevated by a lifting motion imparted to the laryngoscope. The epiglottis will then be seen projecting downwards into the top of endoscopic field.

Step III -The spatular end of the laryngoscope should now be tipped backwards towards the posterior wall of the pharynx passed posterior to the epiglottis and advanced to about 1 cm. The larynx is now exposed by a motion that is described as

a suspension of the head and all the structures attached to the hyoid bone on the tip of the spatular end of the laryngoscope.

If the anterior commissure of the larynx is not readily seen the lifting motion and elevation of the head should be increased and if there is still difficulty in exposing the anterior commissure, the assistant holding the shoulder should press the thyroid cartilage with the index finger applied externally on the neck. The interior of each ventricle is inspected by each ventricular bands in turn. The laryngoscope should be passed through the glottis for the examination of the sub glottic region.

After extrinsic, intrinsic and sub glottic region of the larynx examined, the laryngoscope is passed in to the hypo pharynx for exploration of the posterior wall of the larynx which constitutes the anterior wall of the hypopharynx.

TECHNIQUE OF BRONCHOSCOPY

POSITION OF THE PATIENT

The patient lies supine on the operation table. The head is elevated and neck is flexed and Atlanto-occipital joint extended. Once the bronchoscope has been introduced the head rest is removed and head is allowed to rest flat on the table. This allows satisfactory alignment with the trachea and the right bronchial tree; for axial alignment with the left bronchial tree, the head is rotated to the right.

INTRODUCTION OF BRONCHOSCOPE.

The bronchoscope can be introduced directly - Direct Introduction, or through the laryngoscope - Introduction of the bronchoscope through the laryngoscope or McIntosh laryngoscope.

The bronchoscope was formerly always introduced through the Laryngoscope, the laryngoscope being removed, leaving the bronchoscope in place. In recent years, however the bronchoscope has been routinely introduced directly, without the use of laryngoscope for preliminary exposure of the larynx.

DIRECT INTRODUCTION:

After the patient is placed on the table in the proper position, the bronchoscope is grasped lightly but firmly in the right hand, like a pen, and steadied with the left hand as it is passed back over the tongue, a little towards the right angle of mouth. As the tongue is lifted forwards, the edge of the crest of the epiglottis is visualised (Fig - 14). The tip of the bronchoscope is then passed under the epiglottis and the epiglottis is lifted forwards. The glottis is visualised bronchoscope is then passed as a black opening bordered on each side by vocal chords and posteriorly, by the

posterior commissure (Fig 15). The bronchoscope is introduced in the trachea with the bevel tip facing left (Fig-17).

INTRODUCTION OF THE BRONCHOSCOPE THROUGH THE LARYNGOSCOPE.

This technique comprises of four steps

1) Exposure of the larynx with the spatular laryngoscope.

2) Introduction of the bronchoscope through the laryngoscope. (the tip of the bronchoscope should be to the right and only the left vocal chord is seen through the scope.)

3) Removal of the laryngoscope.

4) Advancement of the bronchoscope and study of the tracheo bronchial tree.

EXAMINATION OF TRACHEA AND BRONCHI

Every landmark and all bronchial orifices must be identified serially, because this is the only way by which the bronchoscopist can know what part of the tree he is examining. From the moment the tube mouth passes the glottis the operator must know at every moment precisely where the tube mouth is. The bronchoscope should be held by the left hand like a billiard cue, the terminal phalanges of the left middle and ring fingers hooking over the scope, clamping it to the teeth tightly or loosely as required. Thus the tube may be anchored in any position, or at any depth and the right hand, which has been directing the tube is free to be used for manipulation of other instruments. The inspection of the walls of the trachea is accomplished by weaving the bronchoscope from side to side and if necessary up and down (Fig-17).

In passing down the trachea the carina (Fig 18) must be identified. Before entering either main bronchus the orifices of both should be identified and inspected. The carina is identified as a sharp, nearly vertical spur at the distal end of trachea,

on either side of it are the openings of the main bronchi. As the carina is situated to the left of the mid line of the trachea, the lip of the bronchoscope should be turned towards the left and slight lateral pressure should be made on the left tracheal wall while the head of the patient is held slightly to the right. This will expose the left bronchial orifice and carina.

ENTERING THE BRONCHI

The lip of the bronchoscope should be turned in the direction of the bronchus to be explored and the axis of the bronchoscope should be made to correspond as nearly as possible to the axis of the bronchus. Upon entering the
right bronchus (Fig-19), the lip of the bronchoscope is turned horizontally to the right and at the same time the assistant deflects the head to the left.

The Right upper lobe bronchus (RUL) (Fig20) is recognised by its vertical spur; the orifice is exposed by displacing the lateral wall of the right main bronchus at the level of carina. If this orifice is not thus brought in to view the bronchoscope may be advanced one or two centimeters, taking care to avoid over riding. This upper lobe broncus is sometimes found coming off the trachea itself. The head must be moved strongly to the left in order to view the orifice. A lumen image of the right upper lobe bronchus is not often obtainable because of the angle at which its given off and the shortness of its stem. To get a good view of this orifice its generally necessary to use the right angle telescope passed through the bronchoscope.

The Left upper lobe bronchus (LUL) (Fig 22) is entered by keeping the lip of the bronchoscope to the left and by keeping the head of the patient strongly to the right as the bronchoscope goes down the left main bronchus. This causes the lip of the instrument to bear strongly the left wall of the left main bronchus, consequently the left upper lobe bronchial orifice (Fig 23,24) will not be over ridden. The spur separating the upper lobe bronchial orifice from the stem bronchus is at an angle approximately from 2 to 8 'O' clock. A lumen image of the lower or "Lingular

division" of the upper lobe bronchus is often obtained if the patients head is displaced strongly enough to the right.

The orifices of the segmental branches of the lower lobe bronchus in either lung are exposed, or their respective lumina presented, by manipulation of the lip of the bronchoscope, with movement of head in the required direction. Posterior branches require the head quite high. Anterior branches require lowering the head.

The middle lobe bronchus is the largest of all the anterior branches. Its almost horizontal spur is brought in to view by properly directing the lip of bronchoscope, and dropping the head of the patient until the lip bears strongly on the anterior wall of the right bronchus.

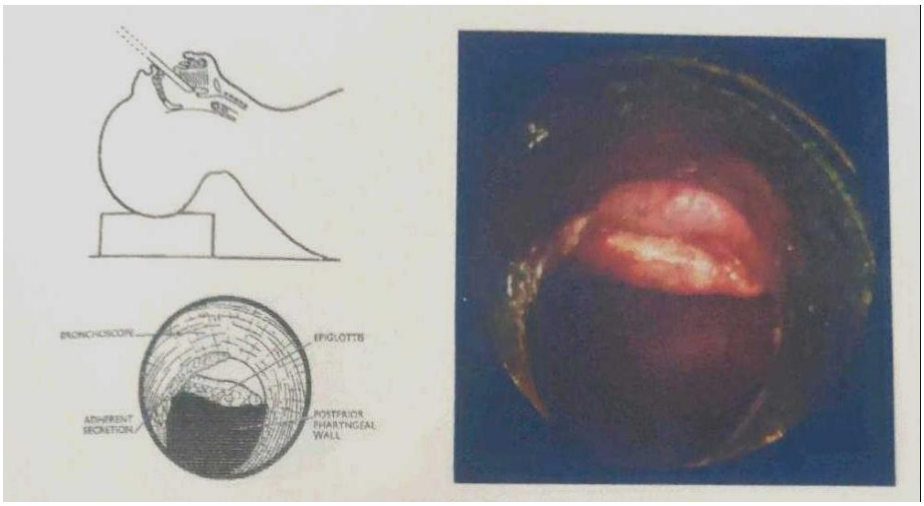

FIG-14: BRONCHOSCOPE AT TIP OF EPIGLOTTIS

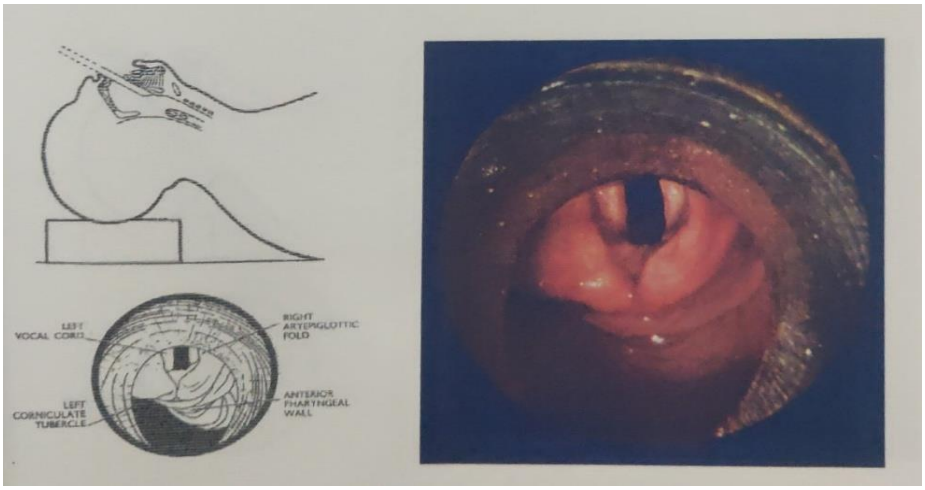

FIG-15: THE ENTRANCE TO THE LARYNX

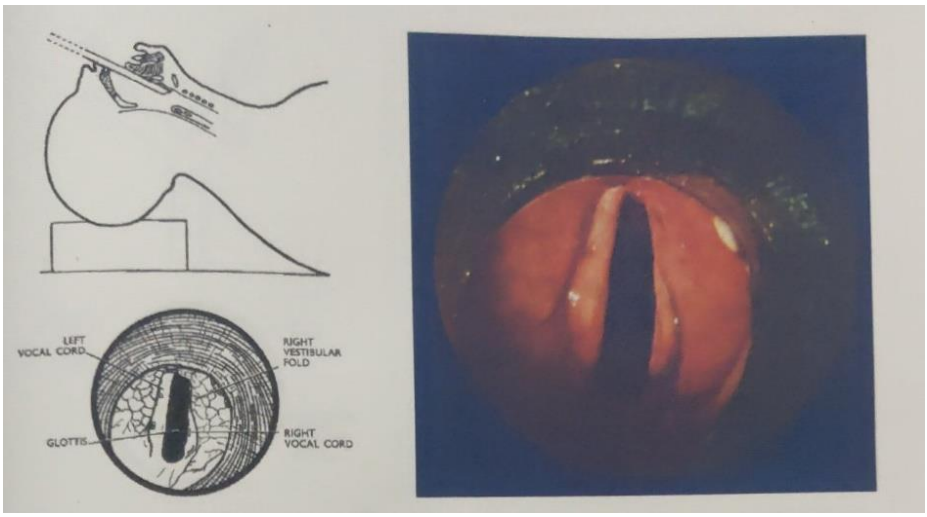

FIG-16: LARYNX AT THE LEVEL OF ARYEPIGLOTTIC FOLD

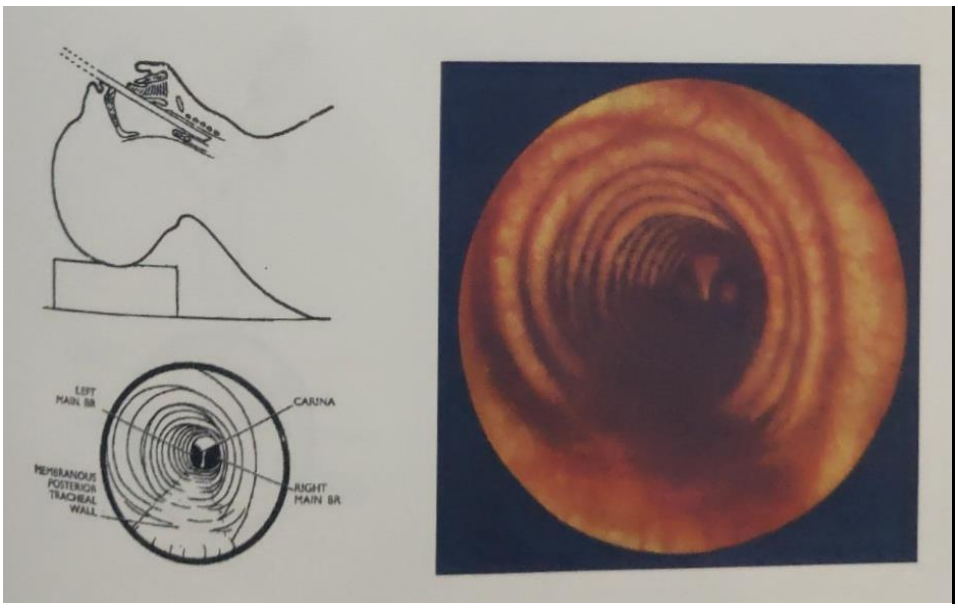

FIG- 17: TRACHEA

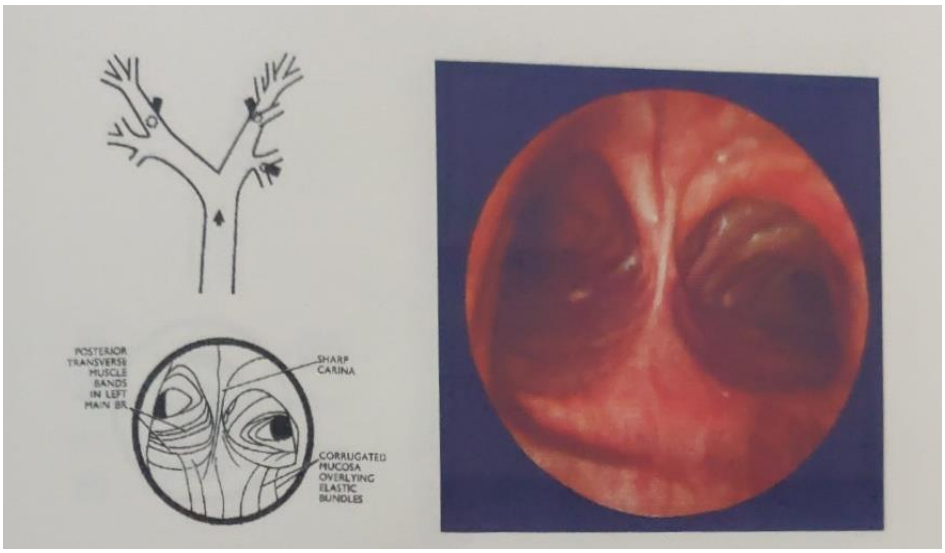

FIG-18: CARINA

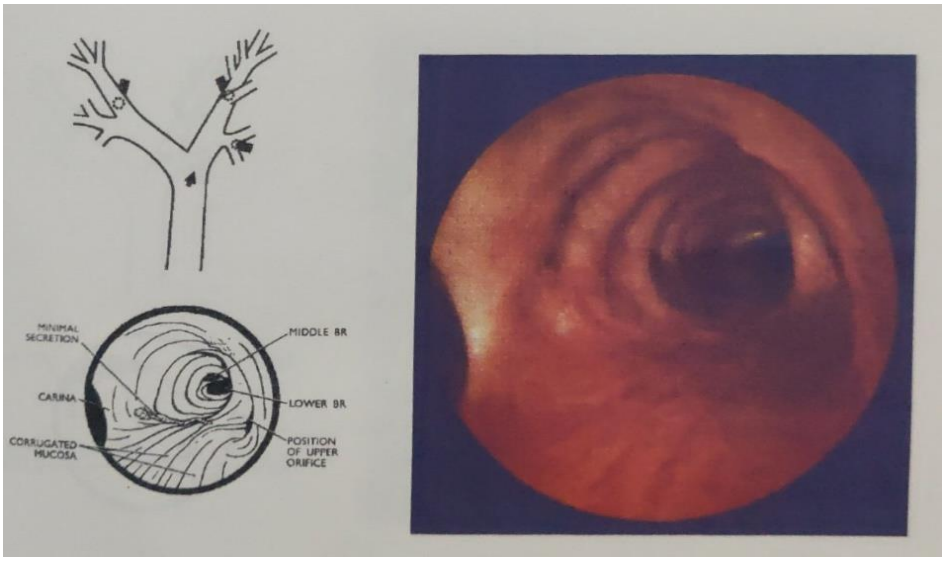

FIG-19: RIGHT MAIN BRONCHUS

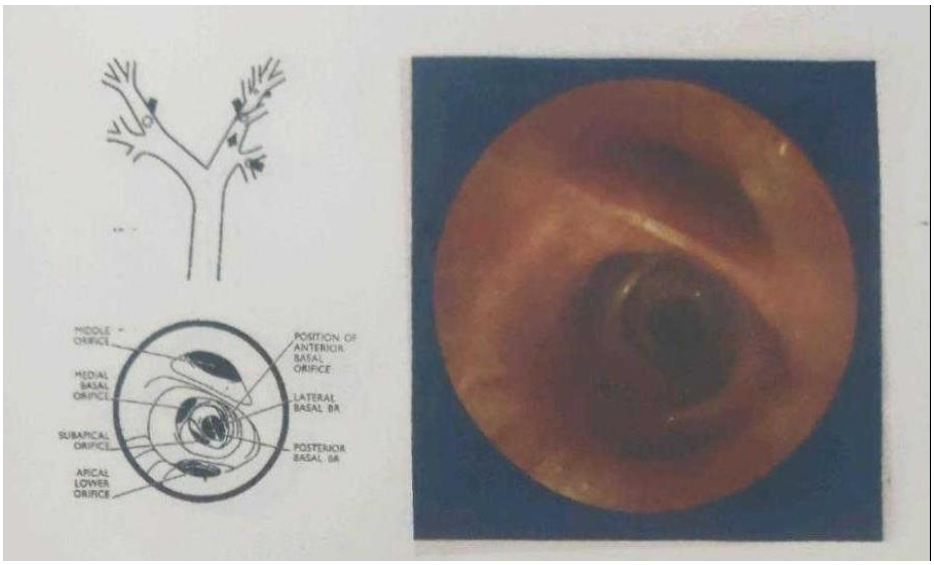

FIG-20: RIGHT UPPER BRONCHIAL ORIFICE

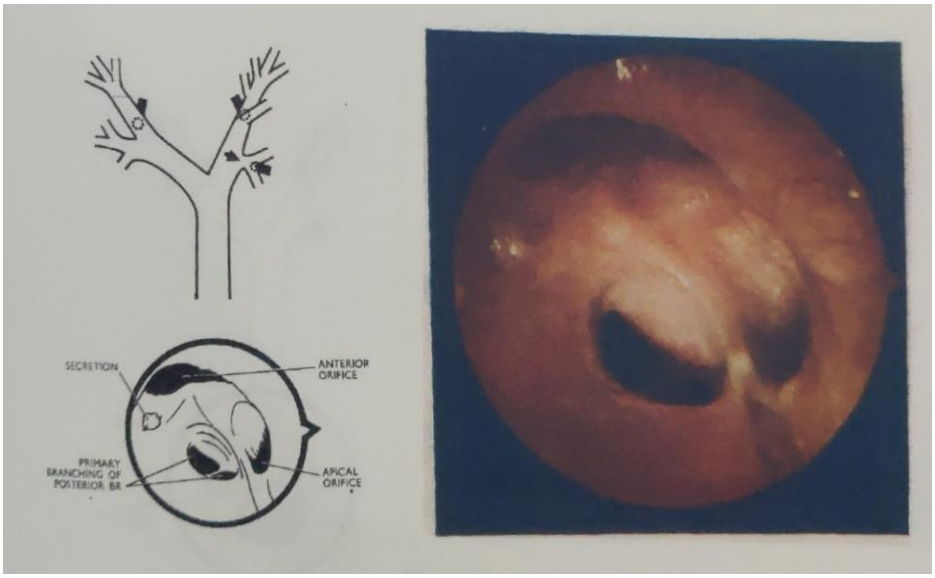

FIG-21: TERMINATION OF RIGHT MAIN BRONCHUS

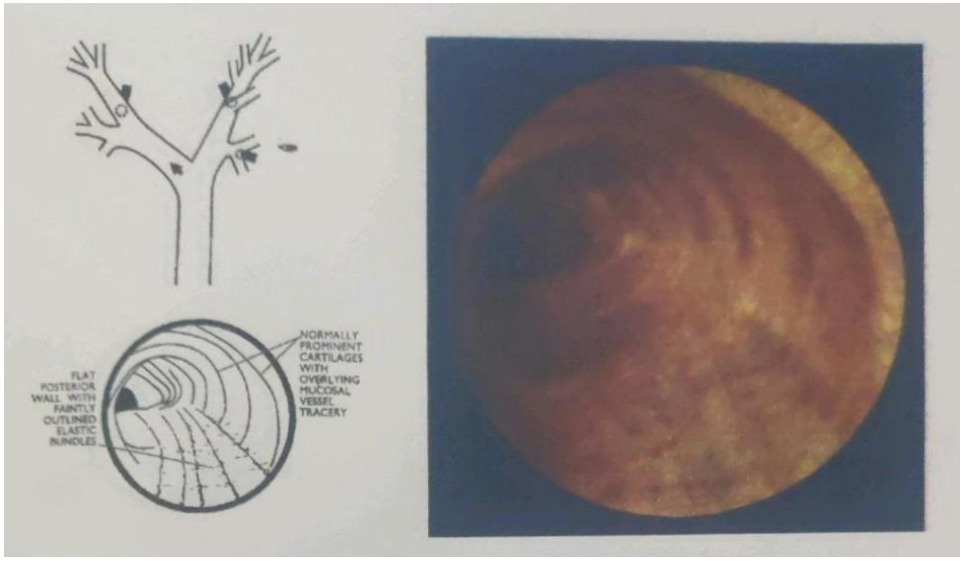

FIG-22: LEFT MAIN BRONCHUS

FIG-23: DIVISION OF LEFT MAIN BRONCHUS

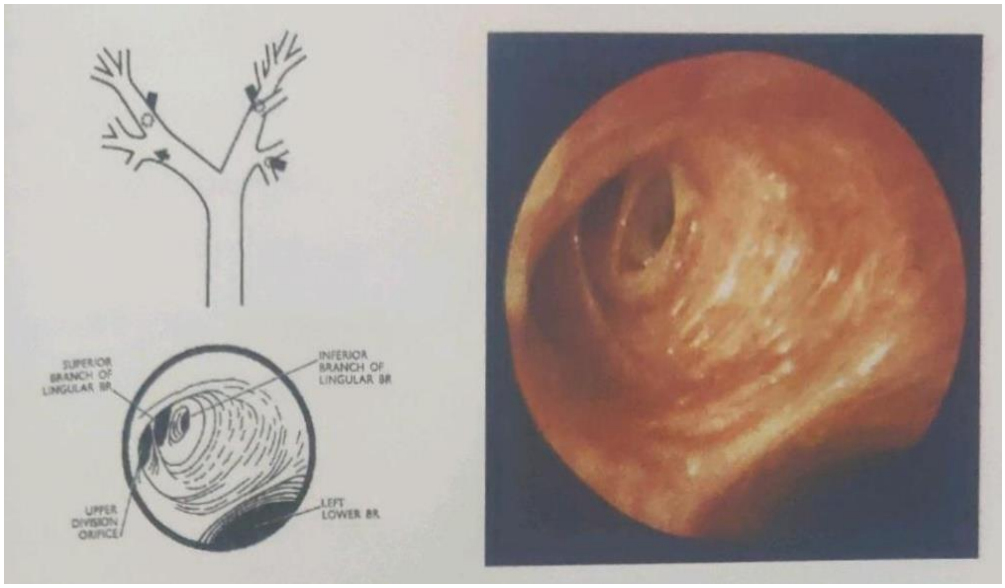

FIG-24: LEFT UPPER BRONCHUS

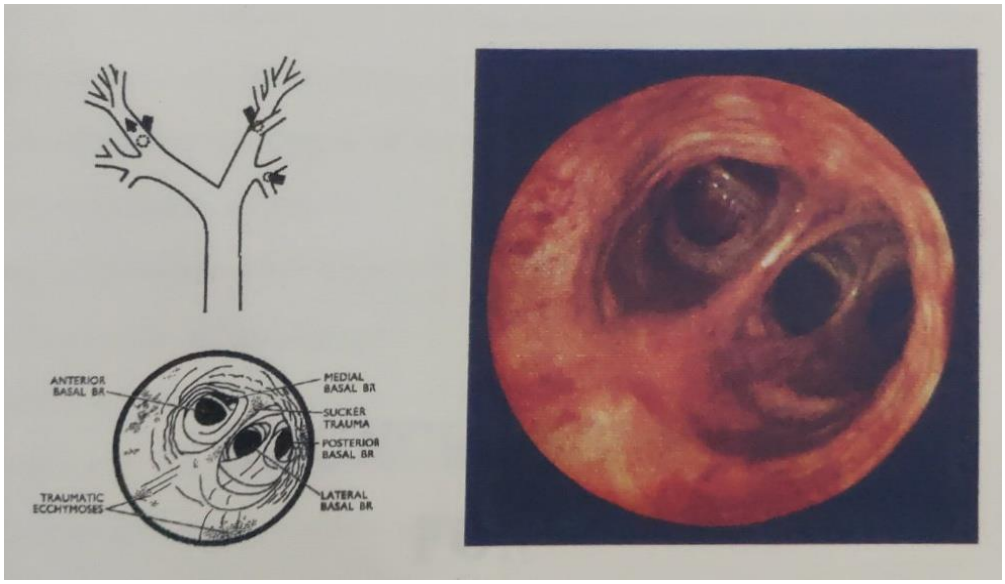

FIG-25: LEFT BASAL BRONCHIAL BRANCHING

BRONCHOSCOPY FOR FOREIGN BODY.

INDICATIONS OF BRONCHOSCOPY FOR FOREIGN BODY

The consensus of bronchologists today is that bronchoscopy is indicated in every case of inspirated foreign body in the lung, present or suspected. In many cases the diagnosis of foreign body can't be made by any means other than diagnostic flexible bronchoscopy. Hence its indicated in even merely suspected cases.

Any form of bronchial obstruction indicated by X-ray and physical examination calls for bronchoscopy to determine the cause of obstruction. Whether located in a natural passage or in the parenchymal pulmonary tissue, peneterating projectiles like bullets and shell fragments call for bronchoscopic removal if they are small enough in their least diameter to permit their being brought up through the corresponding main bronchus.

CONTRA INDICATIONS TO BRONCHOSCOPY FOR FOREIGN BODY.

There are no absolute contra indications for bronchoscopy for foreign body, present or suspected, but there are often some reasons for postponing it. Bronchoscopy has to be postponed if patient is moribund from previous instrumentation. It is advisable not to repeat bronchoscopy in children especially very young children at close intervals. Unless asphyxia or similar urgent condition is present bronchoscopy is contraindicated for a week or two until the child has recovered from shock, dehydration, loss of sleep and fatigue. In cases of subglottic edema from prolonged bronchoscopy a week will usually be long enough for its complete subsidence. Of course a dyspnoeic child should not be unwatched for a moment and low tracheostomy should be done, if indicated, to prevent asphyxia.

X-RAY EXAMNIATION PRECEEDING BRONCHOSCOPY

No matter how many X-ray examinations have been performed, a final X-ray for checking of the presence and position of the foreign body should be made immediately before bronchoscopy as foreign bodies often have a tendency to shift their position with respiration.

CHOICE OF TIME TO DO BRONCHOSCOPY FOR FOREIGN BODY

The difficulties of removal usually increase from the time of inspiration of the object. The foreign body tends to go downwards, while the mucosa becomes edematous, partly closing over the foreign body and even sometimes completely obliterating the lumen in a smaller bronchus. Later development of granulation tissue and formation of stricture, combine to hide the object further.

Organic foreign bodies which produce early and intense inflammatory reaction are liable to swell, call for early, prompt bronchoscopy. When the bronchus is completely obstructed by the bulk of foreign body itself, immediate removal is urgently demanded to prevent development of pathologic changes resulting from atelectasis and lack of drainage. In short, removal of foreign bodies should be accomplished as soon as possible after its entrance. This however doesn't justify hasty, ill planned and poorly equipped bronchoscopy which in most cases is doomed to failure in removal of the object.

Bronchoscopic finding of a foreign body is not especially difficult if the aspiration has been recent. If secondary pathologic processes have developed, or the object is small and in a bronchus too small to admit the tube mouth, considerable search and experience may be necessary to discover it. There is usually inflammatory reaction around the orifice of the invaded bronchus, which serves to localise the intruder. But sometimes the object might have moved.

PRELIMINARY STUDY OF THE MECHANICAL PROBLES IN A PARTICULAR CASE

Attention was first called to vital importance of special study of these problems and their solutions by Chevalier Jackson in 1915.

Step- I Study of X-rays made in at least three planes

a) Antero-posterior

b) Lateral

c) The plane corresponding to the greatest plane of the foreign body

Step- II: Acquisition of an exact duplicate of the foreign body in a particular patient. For radio opaque foreign body radiologist is responsible for selecting an object of same kind an exact duplicate in size, shape and composition. If the foreign body is bent or mutilated, this is imitated on the duplicate.

Step-III : After ascertainment of the size, shape and character of the foreign bodies, similar cases are studied, noting

a)The age of the patient.

b) Size of the tube

c) The kind of forceps

e)Other details of the methods used in the respective cases.

Step-IV: The duplicate of the foreign body is put in a rubber tube of the size of the patient's involved bronchus. The bronchoscope is inserted in the rubber tube to study the bronchoscopic appearance of the duplicate foreign body in as many different positions as possible and for each of these presentations, a method of disimpaction, disengagement, disentaglement is worked out according to the kind of the foreign body.

INTRODUCTION OF THE BRONCHOSCOPE

Prepared by this practice and the radiograhic studies, the endoscopist introduces the bronchoscope in to the patient. The site of location of the foreign body is approached slowly and carefully to avoid overriding or displacement. A study of the presentation is as necessary for the bronchoscopist as for the Obstetrician. It should be made with a view to determine the following points.

1) The relation of the presenting part to the surrounding tissues.

2) The probable position of the unseen portion, as determined by the appearance of presenting part in conjunction with the knowledge obtained from the X-rays.

3) The version or other manipulation necessary to convert an unfavourable in to a favourable presentation for grasping and disengagement.

4) The best instruments to use and which to use first - as hook, pin closer, forceps etc.

5) The presence and position of forceps spaces.

The lip of the Bronchoscope is one of the most valuable aids available in the solution of the foreign body problems. It can convert an unfavourable presentation into favourable one for grasping with forceps; edematous mucosa obstructing the view may be displaced, angles may be straightened and space may be made at the sides of the foreign body for the jaws of the forceps.

The relation of the tube mouth and the foreign body is of vital importance. Generally considered, the tube mouth should be as near the foreign body as possible, and the object must be placed in the center of the bronchoscopic field, so that the ends of the open jaws of the forceps will pass sufficiently far over the object. When the foreign body has been centered in the bronchoscopic field and is placed in a position favourable for grasping, its important that this position be maintained by

anchoring the tube to the upper teeth with the third and fourth fingers of the left hand hooked over the patients upper teeth.

Particular forceps required for the particular foreign body is selected. For delicate manipulation and particularly for friable foreign body, the lighter forceps are best. The most favourable point and position for grasping is determined, the tube fixed against the lower teeth or alveolus. The closed forcep is then inserted through the bronchoscope, blades are opened and turned in such a position that on advancing, the foreign body will enter between the open jaws. The blades are then closed, gently on friable foreign bodies, firmly on uncrushable objects and the tube is advanced until the point of the foreign body is sheathed.

The foreign body in the forceps jaws should be firmly anchored to the tube mouth, otherwise if the foreign body trails a centimeter or more beyond the distal tube mouth, the glottic chink or the backward pressure of the root of the tongue will strip off the foreign body from the forceps grasp. The stripped off foreign body may get jammed in the glottis; otherwise more often get dropped in the trachea or Sometimes stripping off by the tongue and pharyngeal wall may result in swallowing of the foreign body.

The left index finger and thumb grasp the shaft of the forceps close to the ocular end of the tube, while the other fingers encircle the proximal end of the tube, closure of the forceps is firmly maintained by the finger of right hand while all traction for withdrawal is made by left hand, which firmly clasps forceps and bronchoscope as one piece.

Bringing the foreign body through the glottis. Stripping off of the foreign body from the forceps at the glottis may be due to

1)Not keeping the object against the tube mouth

2)Not bringing the greatest diameter of the foreign body into the sagital plane of the glottic chink.

3)Faulty application of the forceps on the foreign body.
4)Mechanically imperfect forceps.

The foreign body lost at the glottis may, if large, become impacted and threaten asphyxia .Prompt insertion of laryngoscope will usually allow removal of the object by means of the laryngeal grasping forceps. The object may be dropped or expelled in to the pharynx and be swallowed. It may even be coughed in to the nasopharynx or it may be reaspirated. In the latter event the bronchoscope is to be reinserted and the trachea inspected. Foreign body getting lodged in the other side, may cause sudden death unless the bronchoscopist promptly inserts his bronchoscope in the previously uninvaded bronchus and removes the foreign body.

MECHANICAL PROBLEMS OF REMOVAL OF SPECIFIC TYPES OF FOREIGN BODIES FROM THE TRACHEOBRONCHIAL TREE

Foreign bodies of different types (Fig-26) as to both form and substance, and in different locations, presents distinct problems, which are discussed as under:

1) coins and discs: such foreign bodies require presentation and a flatwise grasp. They should be kept close against the tube mouth and turned sagitally before the glottis is reached.
2) Pins and Needles and similar long pointed objects: These objects should be divided in to two groups

a) Bendable pins and
b) Breakable pins and needles.

When searching for pins and needles care should be taken not to override them. Pins are almost always found point upwards and the dictum can therefore be made "Search not for the pin but for the point of the pin". If the point is found free, it should be worked, in to the lumen of bronchoscope by manipulation with the lip of the tube. It may be seized with the forceps and withdrawn.. Pins deep in the small bronchus or pins whose shaft is only visible require search under the biplane fluoroscope to find the invaded bronchus.

Point sheathed method - When the point is found to be buried in the mucosa, the best and the usually successful method is to grasp the pin as near the point as possible with the side grasping forceps, then with a spiral motion to push the pin downward while rotating the forceps about 90. The point is thus disengaged and the shaft of the pin is brought parallel with that of the forceps, the point may then be sheathed in the tube mouth by advancing the tube down over the pin.

3) *Tacks, Nails and Large headed Foreign bodies*: If the point of such a foreign body is upper most it presents the same difficulty and require solution in same manner as mentioned in preceding paragraph on extraction of pins.

The large head, however, presents a special problem because of its tendency to act as a mushroom - anchor when buried in swollen mucosa or in a fibrous stenosis. Nails, stick pins and various tacks are dealt with in the same manner by the inward rotation method. Small nails may require fluoroscopic bronchoscopy. The vertebrated magnets are often used. The best forceps for withdrawal of tacks is the head holding forceps.

4) *Hollow metallic foreign bodies:* Such foreign bodies presenting an opening towards the observer are best grasped with regular side grasping forceps, with one jaw inside, the other outside. Should the closed end be uppermost of the object then it is usually best to use the head holding forceps with stiff expanding spring jaws.

5) *Open safety pins*:-Removal of a closed safety pin presents no difficulty if it is grasped at one end or the other end. A grasp in the middle produces a "toggle and ring" action which prevents removal.

When the safety pin is open with the point downward care must be taken not to override it with the bronchoscope or to push the point through the bronchial wall The spring or near end is to be grasped with the rotation forceps. The bronchoscope is then pushed down over the safety pin, thus closing the pin. An open safety pin lodged with point upwards presents an entirely different and a very difficult problem. Here the safety pin closure is excellent.

6) Bits of Wire: If the wire is straight and stiff the problem is similar to that of pins and nails. If it is soft, thin and annealed there is no problem and the foreign body may be seized by any presenting part and drawn in to the tube mouth.

7) *Tightly fitting foreign bodies* :-

Annular Edema:- Such objects as marbles, pebbles, corks or beads are drawn deeply down in to the smallest bronchus they can enter. The air distal to the foreign body is soon absorbed and the negative pressure thus produced increases the impaction. A ring of edematous mucosa soon forms and covers the presenting part of the object, leaving only a small surface visible in the center of an acute edematous stenosis. A forceps with narrow, stiff, expansile spring jaws may repress the edema and create forceps spaces that will allow a grasp on the sides of the foreign body but usually the attempt to apply forceps when there are no spaces between the presenting part of the body and bronchial wall will result only in pushing the foreign body deeper.

8) *Globular, Hard, Smooth surfaced objects* :- Because of the hard surface of these foreign bodies the serrations of the forceps can't sink in to give a secure grasp. Therefore forceps must be chosen as to hold by their shape. The ball forceps holds securely all hard, smooth surfaced, globular objects such as ball bearings, marbles, and globular glass beads. Hard, smooth surfaced beads of ovoid shape are securely held by Gordon bead forceps.

9) *Soft, Friable Foreign bodies*:- The difficulties in removal of such foreign bodies consists in

i) the liability of crushing or fragmenting the object and scattering portions in to minute segmental bronchi.

ii) The difficulty of disimpaction from a ring of annular edema, with little or no forceps space.

iii) The great danger of pushing the foreign bodies downward, so that the swollen mucosa may hide it completely from the view.

Extremely delicate forceps with rather broad but very thin blades is preferred for this work. The fenesterated "Peanut" forceps is best for large pieces of nut kernels in the large bronchi, because they have much less tendency to crush the object grasped. The operator should develop his tactile sense with forceps by repeated practice on peanut kernels, in order to acquire skill to grasp such object as nut kernels, beans, and peas with firmness sufficient to hold them during withdrawal, yet not sufficient to crush them. Small fragments under 2mm in diameter may be expelled with the secretions and fragments may be found on the sponges and in the secretions mechanically aspirated. It is however, never justifiable deliberately to break a friable foreign body with the hope that the fragments will be expelled, for these may be inspirated in to small bronchi and cause multiple abscesses.

10) *Animal objects* - Such foreign bodies are readily removed with the side curved forceps. Leeches are often found in European countries, if it is alive it will be attached to wall of the passage invaded. In such event, cocaine or salt solution may be used to cause the leech to loosen its hold. Small insects are usually coughed out. If not, they are readily removed with forward grasping forceps, Small fishes, larvae, and worms can also be found in the tracheobronchial tree.

11) *Removal of Foreign bodies in upper lobe bronchus*- Foreign bodies are not commonly found in this location. If the intruder is ferrous and free to move, it may be removed with vertebrated magnet, designed on the principle of the upper lobe bronchus forceps, by coil spring hooks, or by vertebrator aspirator. All these instruments should be used with biplane fluoroscopic guidance.

If the object is not ferrous and it is not too far out towards the periphery, it may be grasped by the upper lobe bronchus forceps.

12) Middle Lobe Bronchus :- Such foreign bodies if located at the orifice are readily presented by lowering the head of the patients. If they are deep in the lateral segments, the flouroscope may be required.

Second Look Bronchoscopy After removal of the foreign body: The bronchoscope is again introduced and check/second look bronchoscopy done so that if any remnant of the foreign body can be removed. Even sometimes multiple foreign bodies may be present and sometimes the foreign bodies often shift Wandering foreign body.

Post operatively patient is put on steam inhalation, nebulisation and four doses of dexamethasone at the interval of 6 hours is given. A course of antibiotics is started. Later on from the next day chest physiotherapy is advised.

AXIOMS OF FOREIGN BODY REMOVAL

The following axioms of the Chevalier Jackson Bronchoscopic Clinic have stood the test of time:

1) Never do an endoscopy in a foreign body case unprepared.

2) Approach carefully the suspected location of a foreign body so as not to override any portion of it.

3)Avoid grasping a foreign body hastily as soon as seen.

4) The shape size and position of a foreign body, and its relations to surrounding structures, should be studied before attempting to apply the forceps.

5) Preliminary endoscopic study of the foreign body should be made without contact.

6) As the first grasp of the forceps is the best it should be well planned beforehand so as to permit grasping the proper part of the intruder in the proper manner.

7) With all long foreign bodies the axiom is to search not for the foreign body but for the near end.

8) A long foreign body grasped near the middle becomes, mechanically speaking, a "toggle and ring" unless it can be folded in the tube mouth.

9)Remember that mortality which may follow failure to remove a foreign body does not justify violence during its removal.

10) Laryngeally and pharyngeally lodged foreign bodies, because of the likelihood of dislodgment and loss into the deeper air passages, it should be seized by any part first presented, and the plan of withdrawal determined after its grasped.

11) In laryngeal cases, it is better to have the table inclined toward the head.

12) An esophagoscopy may be necessary in a bronchial case, or a bronchoscopy in an esophageal case. In every case both kind of tubes should be sterile and ready before hand for immediate use if needed.

13) Do not pull on a foreign body unless you are sure it is properly grasped to come away readily without trauma, then do not pull hard.

14) Keep the foreign body against the tube mouth.

15) Do not harm, if you cannot remove the foreign body.

16) Be careful to avoid grasping spurs between bronchial orifices.

17)While working deep in a bronchus, the breathing threatens to cease, or the condition of the patient becomes critical from cardiac or other cause, do not withdraw the bronchoscope all the way; withdraw it until the distal end is about 1cm from the bifurcation. It will then ensure good ventilation of both lungs.

18) Full curved hooks are to be used in the bronchi with greatest caution, if at all, lest they catch inextricably in branch bronchi.

19) Beware of forcing a foreign body downwards. Coax it back. The deeper it gets the greater the difficulties become.

20) The watch word of the bronchoscopist should be, "If I can do no good, I will at least do no harm". Further more if no harm is done, subsequent trials will almost certainly be successful.

FIG-26: SAMPLES OF FOREIGN BODIES REMOVED

MATERIALS AND METHODS

SOURCE OF DATA:

Patients satisfying the inclusion and exclusion criteria who attend the department of Otorhinolaryngology and Paediatrics OPD in BLDE's (Deemed to be university) Shri B.M Patil Medical College Hospital and Research Centre, Vijayapura are studied to see the role of flexible bronchoscopy in early diagnosis and management of laryngotracheobronchial foreign bodies.

Study Design: Hospital based Cross sectional study

Study Duration: From November 2019 to August 2021

Sample Size: 36 patients

INCLUSION CRITERIA

1) All patients with history of foreign body aspiration.
2) All patients with suspicion of foreign body in airway.
3) All patients with unresolved pneumonia after course of antibiotics and with physical signs suggestive of foreign body in the airway.

EXCLUSION CRITERIA

1) Patients who didn't give consent for Flexible/Rigid Bronchoscopy.

METHOD OF COLLECTION OF DATA

- Detailed clinical history with thorough examination of the patient is done followed by routine blood investigations, serology and chest X ray- PA view and lateral view.
- Patients with suspicion of foreign body aspiration will be subjected to flexible bronchoscopy under Local Anesthesia/ Monitored Anesthesia Care followed by rigid bronchoscopy under General Anesthesia if foreign body is visualized on flexible bronchoscopy.
- In paediatric age group, Pentax flexible bronchoscope number 2.8 is used for flexible bronchoscopy.
- Karl storz rigid bronchoscope of size 3.5, 4, 5, 6 and 7.5 are used according to the age of the patient for rigid bronchoscopy and foreign body removal.
- Depending on the nature, site and size of foreign body, appropriate forceps are used for removal like peanut forceps, cup forceps, heavy duty forceps.
- If definitive history of foreign body aspiration is available, flexible bronchoscopy is done and the site, size and nature of foreign body is noted. Also any granulation, mucosal edema, pooling of secretions around the foreign body are noted.
- Based on the site, size and nature of foreign body, appropriate forceps is chosen for removal of foreign body using rigid bronchoscope, which helps to reduce the duration of the procedure and hence, reduce the complications.
- If no definitive history of foreign body aspiration is available, and there is suspicion on clinical examination and chest X-ray, Flexible bronchoscopy can

be done for definitive diagnosis of foreign body. And if foreign body is visualized, then removal is done using rigid bronchoscope.

- Symptoms and signs of foreign body of airway simulate the symptoms and signs of common airway diseases like asthma, bronchitis, pneumonia, empyema. Hence in cases of unresolved pneumonia or in cases of airway diseases not responding to medical treatment, foreign body in the airway should be suspected and patient should be subjected to flexible bronchoscopy to rule out if any.

- After removal of foreign body, again the bronchoscope is passed inside to see if the foreign body is removed in toto or if any second foreign body was there distal to the first one and to see for any secretions distally, if present, is suctioned out.

- Flexible bronchoscopy can be repeated on day 2 or 3 following first bronchoscopy if there is doubt of any retained foreign body in terms of no improvement in symptoms like persistence of cough, reduced air entry, etc. following first bronchoscopy.

Data of cases with flexible bronchoscopy positive and negative for foreign body is collected.

STATISTICAL ANALYSIS:

All characteristics will be summarized descriptively. For continuous variables, the summary statistics of N, mean, median, IQR and standard deviation (SD) will be used. For categorical data, the number and percentage will be used in the data summaries and data will be analyzed by Chi square test or Fishers exact test for association, comparison of means using, sensitivity, specificity and diagrammatic presentation.

By using the formula:

$$n = \frac{z^2 p(1-p)}{d^2}$$

where

Z= z statistic at 5% level of significance

d is margin of error

p is maximum anticipated prevalence rate

If the p- value was less than (<0.05) , then the results were considered to be statistically significant.

OBSERVATION AND RESULTS

A hospital based prospective cross sectional study was conducted on 36 patients over the period from November 2019 to August 2021 to know the role of flexible bronchoscopy in early diagnosis and management of laryngotracheobronchial foreign bodies.

AGE INCIDENCE:

TABLE-5: AGE DISTRIBUTON OF CASES (N=36)

AGE GROUP (YRS)	NO. OF CASES	%
<1	3	8.33
1-3	24	66.67
3-7	4	11.11
7-10	2	5.56
10-12	1	2.78
>12	2	5.56
TOTAL	36	100

The present study includes patients ranging from 4 months to 56 years of age, median age was 2.25 years (IQR 1.06-3 years). The most commonly affected age group was 1 to 3 years, which included 24 (66.67%) patients. This was followed by patients belonging to the age group of 3 to 7 years and less than 1 year with 4(11.11%) and 3 (8.33%) patients in each group respectively.

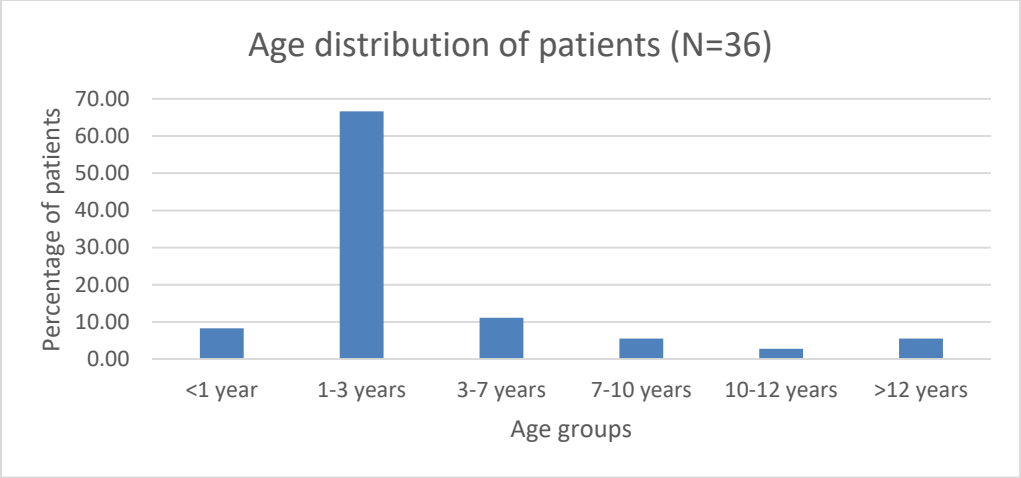

FIG-27: AGE DISTRIBUTION OF PATIENTS

TABLE 6: GENDER DISTRIBUTION OF CASES (N=36)

SEX	NO. OF CASES	%
MALE	24	66.67
FEMALE	12	33.33
TOTAL	36	100

Out of the 36 patients in this study, 24 (66.67%) were males and 12 (33.33%) were females. Male to female ratio is 2:1

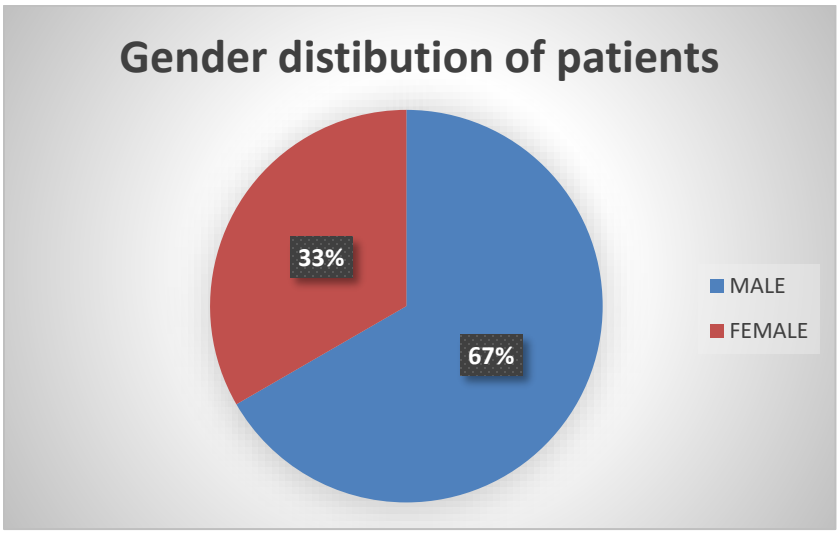

FIG-28: GENDER DISTRIBUTION OF PATIENTS

TABLE-7: HISTORY OF ASPIRATION OF FOREIGN BODY (N=36)

HISTORY OF ASPIRATION OF FOREIGN BODY	FREQUENCY	PERCENT
POSITIVE	16	44.4
DOUBTFUL	3	8.3
NEGATIVE	17	47.2
TOTAL	36	100

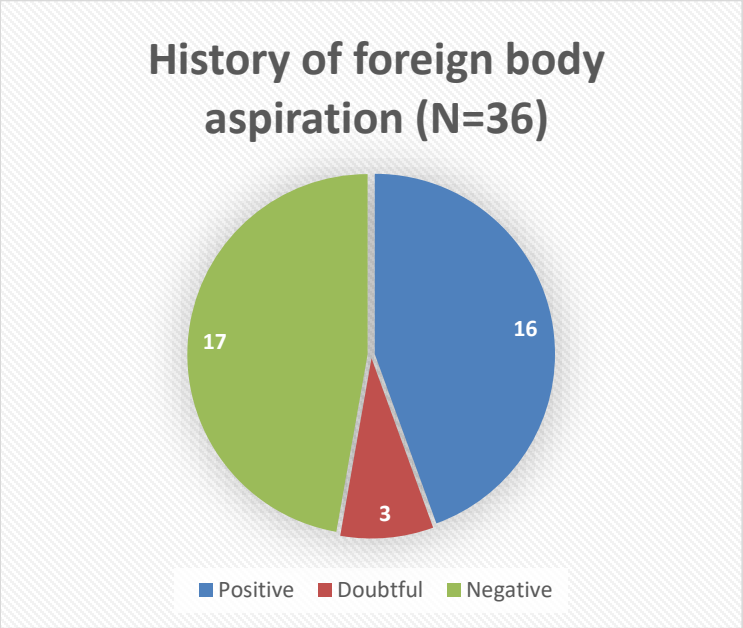

FIG-29: HISTORY OF ASPIRATION OF FOREIGN BODY

Among 36 patients, 16(44.4%) gave positive history of foreign body aspiration, 3(8.3%) gave doubtful history and 17(47.2%) gave negative history of foreign body aspiration.

TABLE -8: PRESENTING SYMPTOMS (N=36)

SYMPTOMS	NUMBER OF PATIENTS	PERCENTAGE
COUGH	36	100
CHOKING	16	44.4
VOMITING	3	8.3
BREATHLESSNESS	7	19.4
NOISY BREATHING	21	58.3

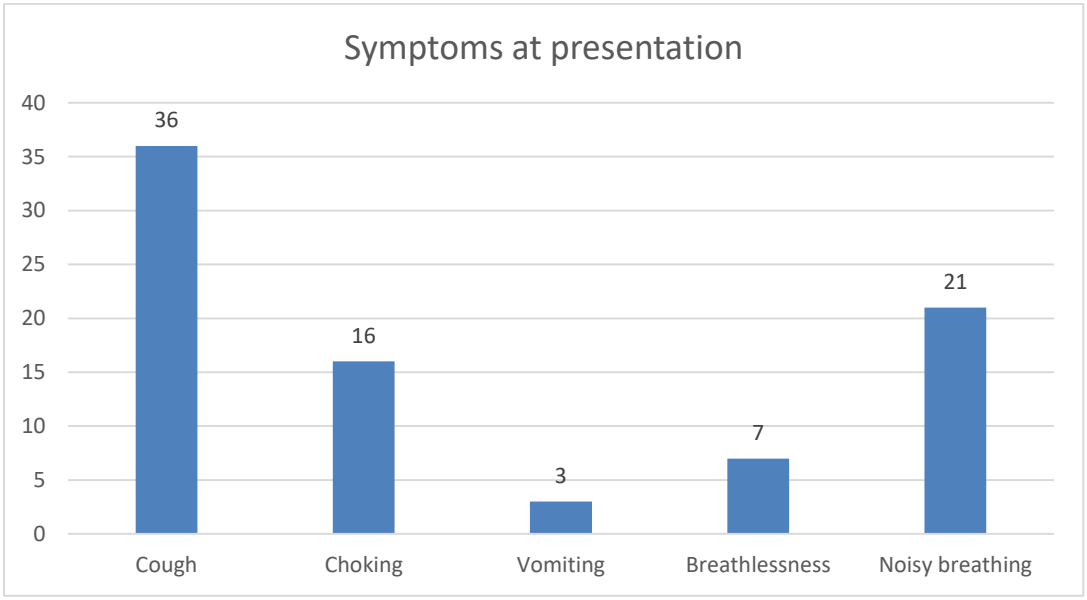

FIG-30: SYMPTOMS AT PRESENTATION

Among 36 patients, all 36 had cough which was the commonest presentation, followed by noisy breathing in 21(58.3%) patients and then choking in 16(44.4%) patients. Breathlessness was a presenting symptom in only 7(19.4%) patients. And 3(8.3%) patients also gave history of vomiting.

TABLE-9: DURATION OF SYMPTOMS (N=36)

DURATION OF SYMPTOMS	NUMBER OF PATIENTS	PERCENT
<1 Day	13	36.1
1-3 days	7	19.4
3-7 days	6	16.7
7-15 days	5	13.9
15-30 days	4	11.1
> 30 days	1	2.8

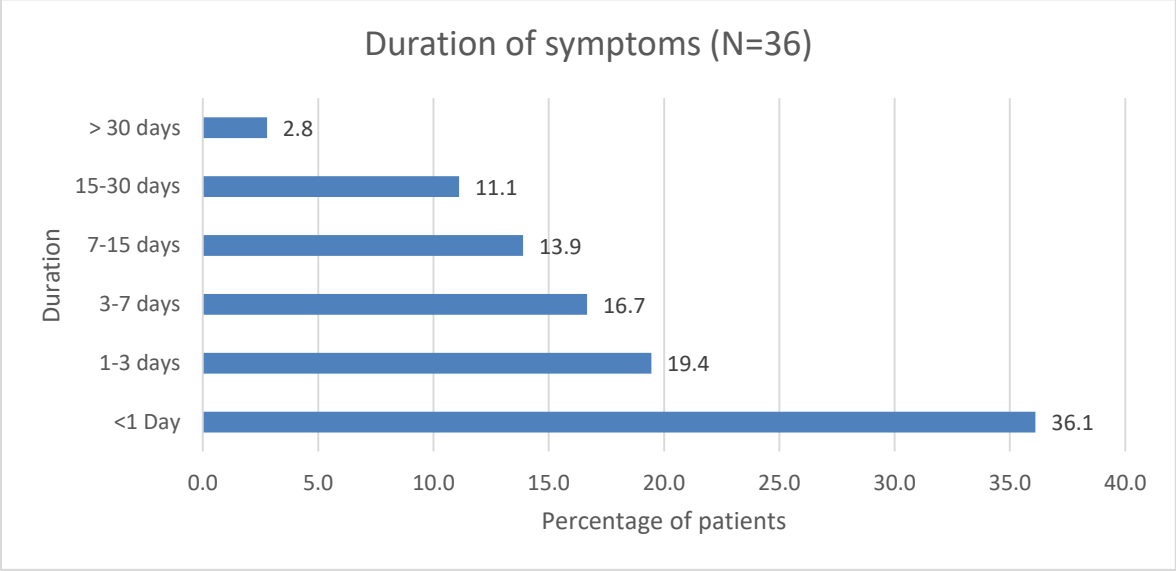

FIG-31: DURATION OF SYMPTOMS

Among 36 patients, 13(36.1%) have presented within 1 day, followed by 7(19.4%) who presented by 3 days of symptoms, followed by 6(16.7%) who presented within a week of symptoms.

TABLE-10: SIGNS AT PRESENTATION

SIGNS AT PRESENTATION	NUMBER OF PATIENTS	PERCENTAGE
DYSPNEA	16	44.4
STRIDOR	3	8.3
AIR ENTRY EQUAL AND BILATERALLY REDUCED	2	5.6
AIR ENTRY REDUCED ON ONE SIDE	30	83.3
U/L RHONCHI AND/OR CREPTS	33	91.7
B/L RHONCHI AND/OR CREPTS	4	11.1
SURGICAL EMPHYSEMA	1	2.8

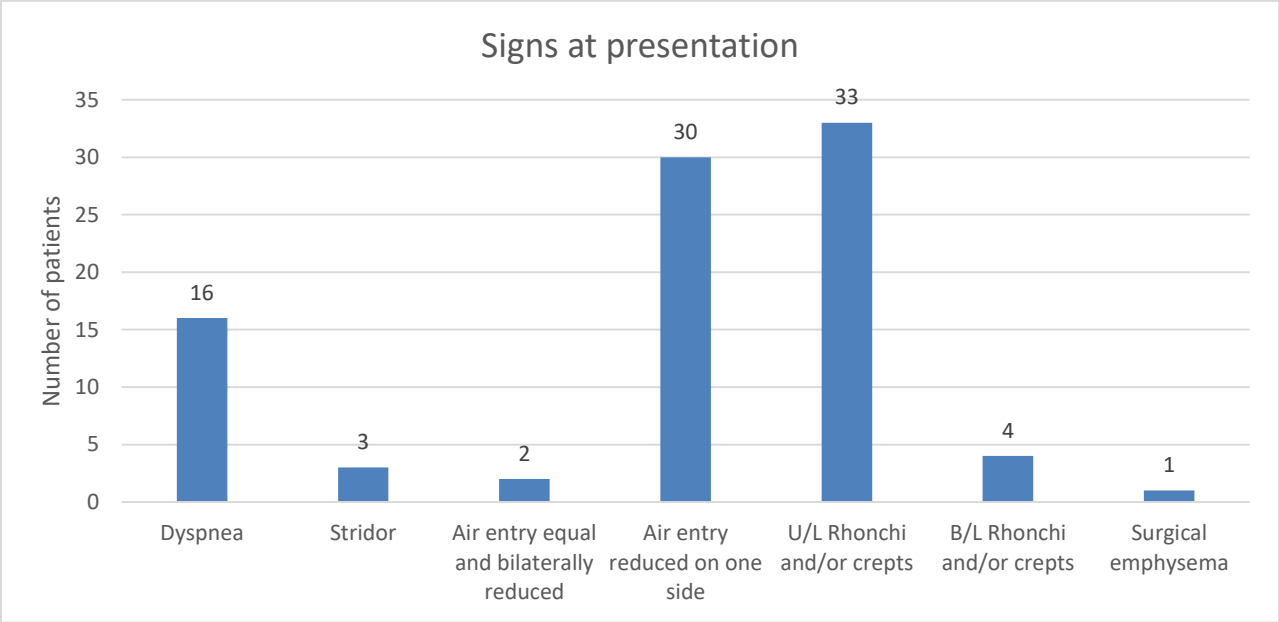

FIG-32: SIGNS AT PRESENTATION

Unilateral rhonchi/crepts was the commonest sign seen in 33(91.7%) patients, followed by reduced air entry on one side in 30(83.3%) patients, followed by Dyspnoea in 16 (44.4%) patients. Stridor was present in 3(8.3%) patients and 1(2.8%) patient had developed surgical emphysema.

TABLE-11: X-RAY FINDINGS (N=36)

X RAY FINDINGS	NUMBER OF PATIENTS	PERCENTAGE
NORMAL	20	55.6
COLLAPSE	1	2.8
CONSOLIDATION/PNEUMONITIS	6	16.7
OBSTRUCTIVE EMPHYSEMA	7	19.4
PNEUMOTHORAX + SURGICAL EMPHYSEMA	1	2.8
FOREIGN BODY SEEN	1	2.8

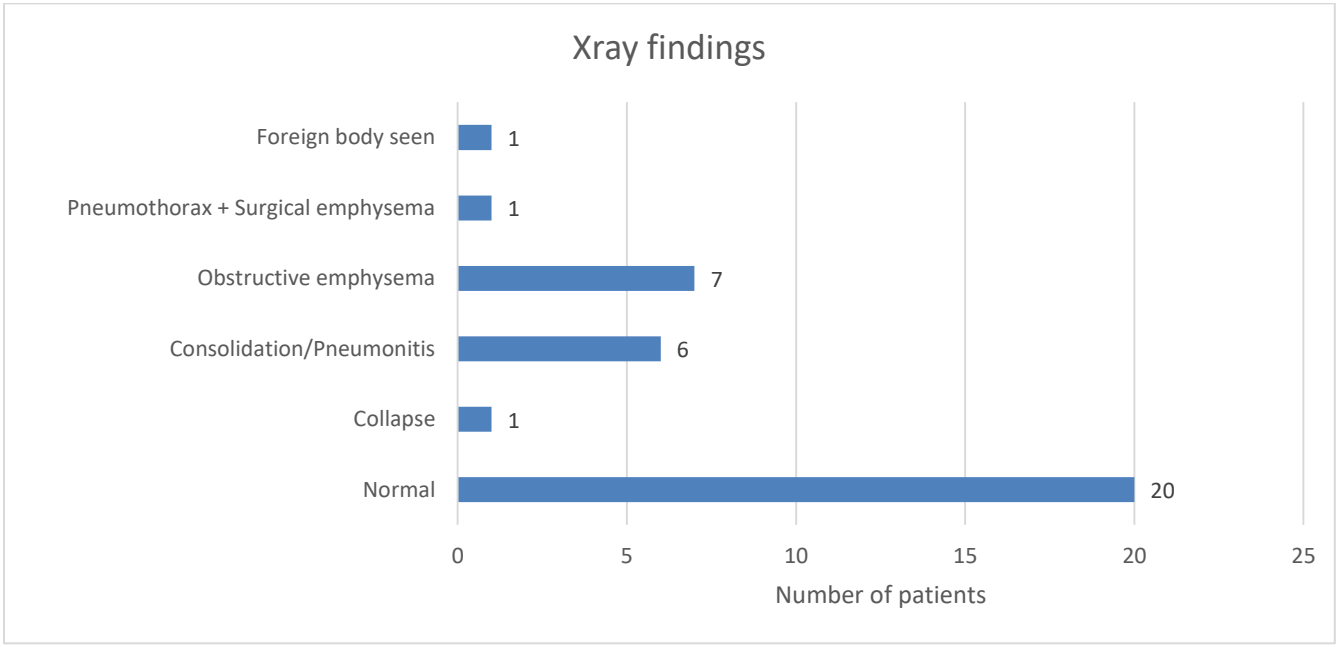

FIG-33: X- RAY FINDING

Out of 36 patients, 20(55.6%)had a normal X ray, 7(19.4%) had obstructive emphysema, 6(16.7%) had Pneumonitis. 1(2.8%) patient had lung collapse and another 1(2.8%) patient developed Pneumothorax with Surgical emphysema.

TABLE-12: TYPE OF FOREIGN BODY ASPIRATED (N-=32)

TYPE OF FOREIGN BODY ASPIRATED	NUMBER OF PATIENTS	PERCENTAGE
PEANUT	11	34.4
CASHEWNUT	2	6.3
BENGAL GRAM	1	3.1
TAMARIND SEED	2	6.3
TOOR DAL	1	3.1
COCONUT PIECE	3	9.4
GRASS WEED	2	6.3
PLASTIC PEN TIP	1	3.1
WHEAT SEED	1	3.1
WHISTLE	2	6.3
SITAPHAL SEED	2	6.3
CORN SEED	1	3.1
BETEL NUT	2	6.3
MUTTON PIECE	1	3.1
TOTAL	32	100.0

Among 32 patients, the commonest foreign body aspirated was peanut by 11(34.4%) patients followed by coconut piece in 3(9.4%). Both organic and inorganic foreign bodies were aspirated.

TABLE-13: NATURE OF FOREIGN BODY (N=32)

	NUMBER OF PATIENTS	PERCENT
ORGANIC	29	80.6
INORGANIC	3	8.3

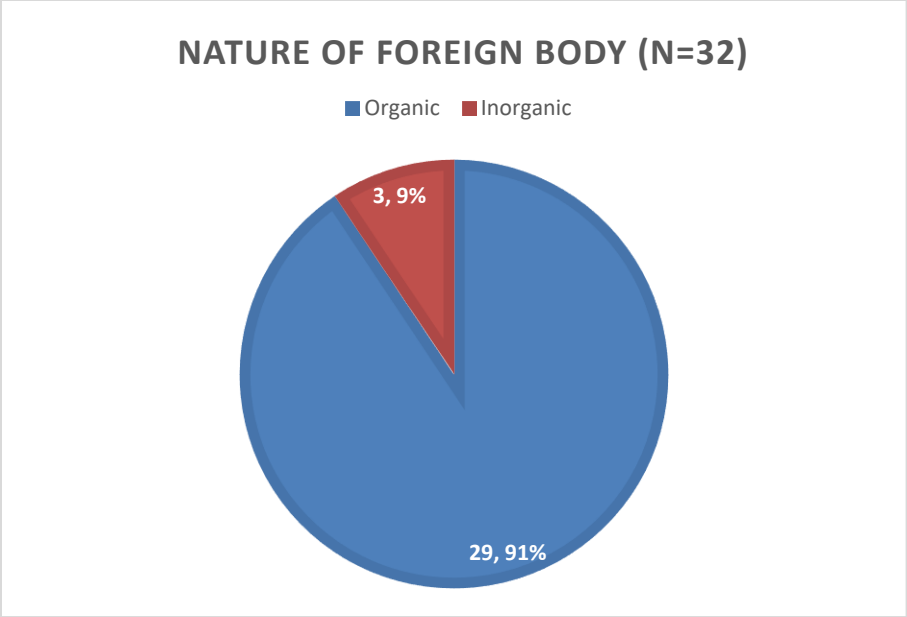

FIG-34: NATURE OF FOREIGN BODY

Among 32 foreign bodies, 29 were organic and 3 were inorganic.

TABLE-14: SITE OF IMPACTION OF FOREIGN BODY

SITE	NUMBER OF PATIENTS	PERCENTAGE
LARYNX	1	3.1
TRACHEA	1	3.1
RIGHT MAIN BRONCHUS	16	50.0
LEFT MAIN BRONCHUS	13	40.6
LEFT LOWER LOBE BRONCHUS	1	3.1

Commonest site of impaction was Right main bronchus 16(50%) followed by left main bronchus 13(40.6%).

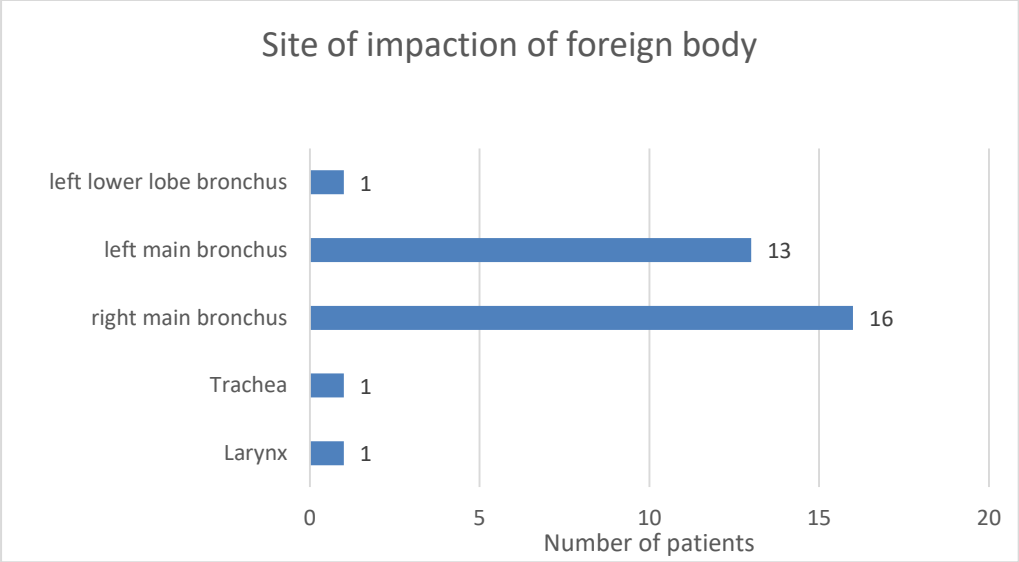

FIG-35: SITE OF IMPACTION OF FOREIGN BODY

TABLE-15 : HISTORY OF FOREIGN BODY ASPIRATION AND FINDING ON FLEXIBLE BRONCHOSCOPY

HISTORY OF FOREIGN BODY ASPIRATION	FB PRESENT ON FL. BR.	FB ABSENT ON FL. BR.	p-VALUE*
POSITIVE	16 (44.4%)	0	0.162
DOUBTFUL	3 (8.3%)	0	
NEGATIVE	13 (36.11%)	4 (11.11%)	

* Chi-square test (Exact) was used as test of significance

Among 36 patients, 16 gave positive history of foreign body aspiration, 3 gave doubtful history and 17 gave negative history of foreign body aspiration. On flexible bronchoscopy foreign body was present in all 16(44.4%) of positive history group, 3(8.3%) of doubtful history group and 13(36.11%) of negative history group. On

flexible bronchoscopy, foreign body was absent in 4(11.11%) patients of negative history group.

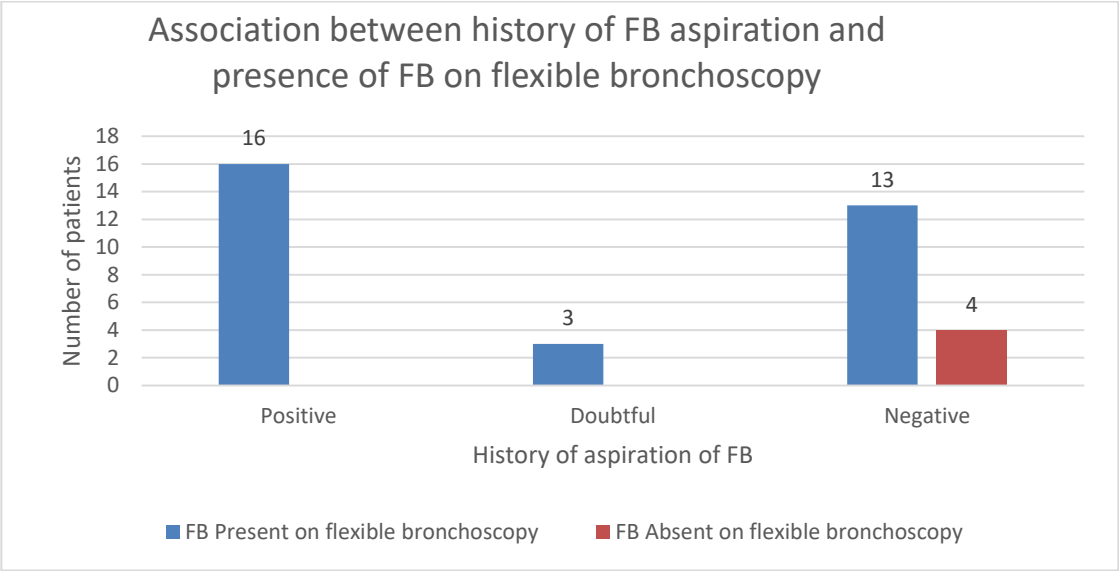

FIG-36: HISTORY OF FOREIGN BODY ASPIRATION AND FINDING ON FLEXIBLE BRONCHOSCOPY

p-value = 0.162 by Chi-square (exact) test

- Positive predictive value of history of FB aspiration including positive and doubtful history (PPV) = (19/19) x 100 = 100%

- Negative predictive value of history of FB aspiration (NPV) = (4/17) x 100 = 23.5%

- Sensitivity of history of FB aspiration = (16+3) / 32 x 100 = 52.8%

- Specificity of history of FB aspiration = 4 / 4 x 100 = 100%

TABLE- 16 :SYMPTOMS IN PATIENTS WITH FOREIGN BODY ON FLEXIBLE BRONCHOSCOPY

SYMPTOMS	FB PRESENT	FB ABSENT	P VALUE*	PPV (%)	NPV (%)	SEN(%)	SPE (%)
COUGH	32	4	-				
CHOKING	16	0	0.113	100	20	50	100
VOMITING	3	0	1	100	12.12	9.38	100
BREATHLESSNESS	7	0	0.566	100	13.79	21.88	100
NOISY BREATHING	21	0	0.023	100	26.67	65.63	100

Among 32 patients with foreign body on flexible bronchoscopy, the commonest presentation was cough in 32 patients followed by noisy breathing in 21 patients

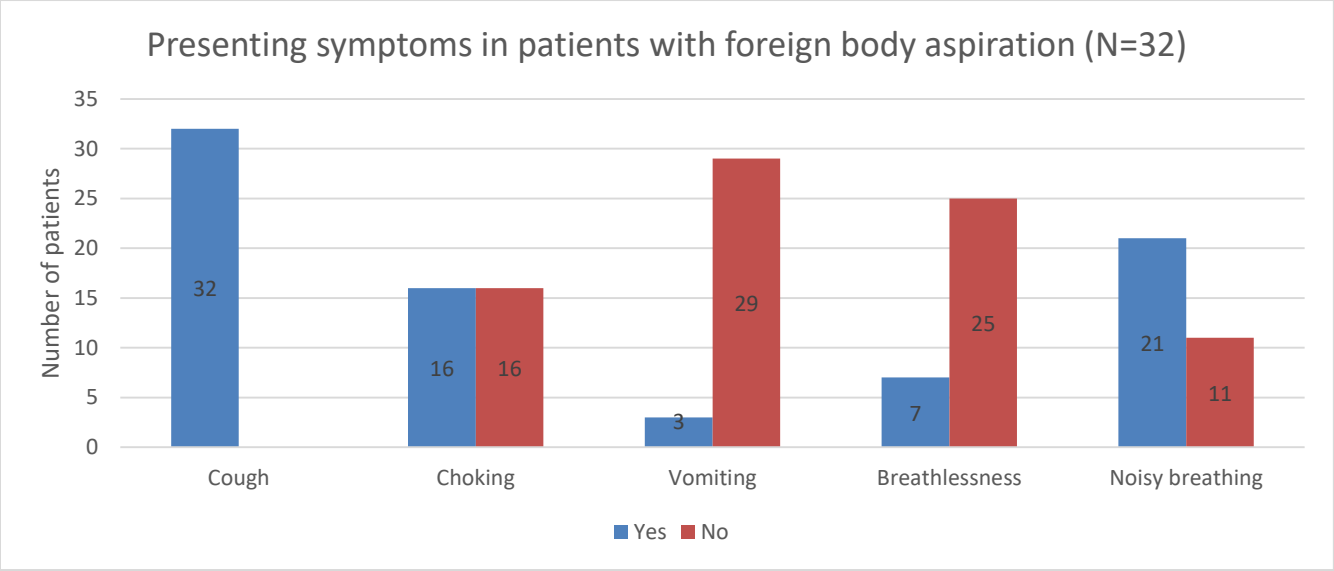

FIG-37:SYMPTOMS IN PATIENTS WITH FOREIGN BODY ON FLEXIBLE BRONCHOSCOPY

TABLE-17: SIGNS IN PATIENTS WITH FOREIGN BODY ON FLEXIBLE BRONCHOSCOPY

SIGNS	FB PRESENT	FB ABSENT	P VALUE*	PPV (%)	NPV (%)	SEN(%)	SPE(%)
DYSPNEA	14	2	1	87.5	10	43.75	50
STRIDOR	3	0	1	100	12.12	9.37	100
AIR ENTRY EQUAL BUT BILATERALLY REDUCED	2	0	1	100	11.76	6.25	100
AIR ENTRY UNILATERALLY REDUCED	28	2	0.12	93.33	33.33	87.5	50
UNILATERAL RHONCHI/CREPTS	29	4	1	87.87	0	90.62	0
BILATERAL RHONCHI/CREPTS	4	0	1	100	12.5	12.5	100
SURGICAL EMPHYSEMA	1	0	1	100	11.42	3.12	100

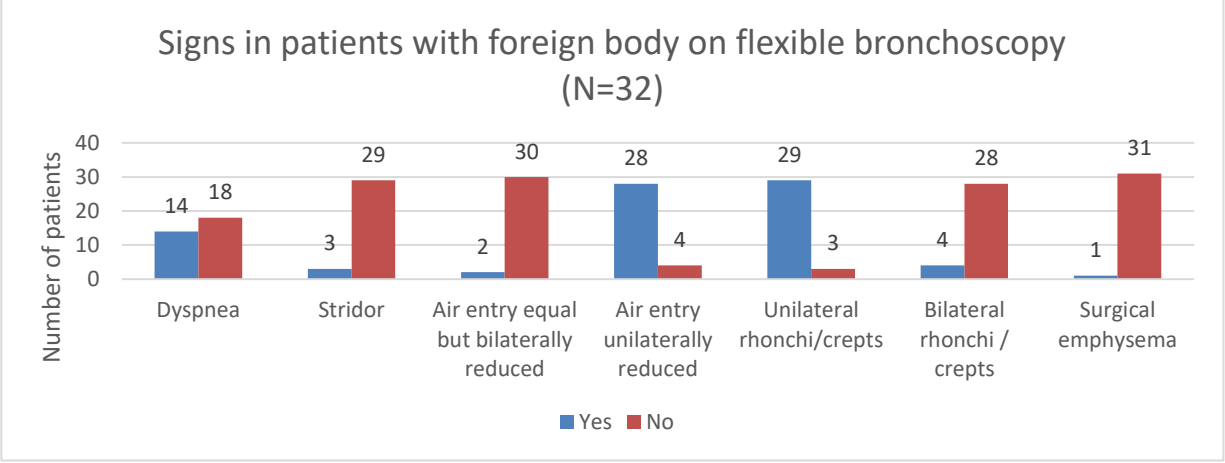

FIG-38: SIGNS IN PATIENTS WITH FOREIGN BODY ON FLEXIBLE BRONCHOSCOPY

Among 32 patients who had positive foreign body on flexible bronchoscopy, 29 had unilateral rhonchi/ crepts, 28 had air entry less on one side, which was the commonest finding on clinical examination.

TABLE-18: X RAY FINDINGS AND FB ON FLEXIBLE BRONCHOSCOPY

XRAY FINDINGS	FB PRESENT	%	FB ABSENT	%	PPV%	NPV%	SEN%	SPE%
NORMAL	19	52.8	1	2.8	-	-	-	-
ABNORMAL	13	36.1	3	8.3	81.3%	5.0%	40.6	25.0
COLLAPSE	1	2.8	0	0.0	100.0%	11.4%	3.1	100.0
CONSOLIDATION	3	8.3	3	8.3	50.0%	9.4%	9.4	50.0
OBSTRUCTIVE EMPHYSEMA	7	19.4	0	0.0	100.0%	13.8%	21.9	100.0
PNEUMOTHORAX + SURGICAL EMPHYSEMA	1	2.8	0	0.0	100.0%	11.4%	3.1	100.0
FOREIGN BODY SEEN	1	2.8	0	0.0	100.0%	11.4%	3.1	100.0

P-VALUE 0.075 BY FISHER'S EXACT TEST

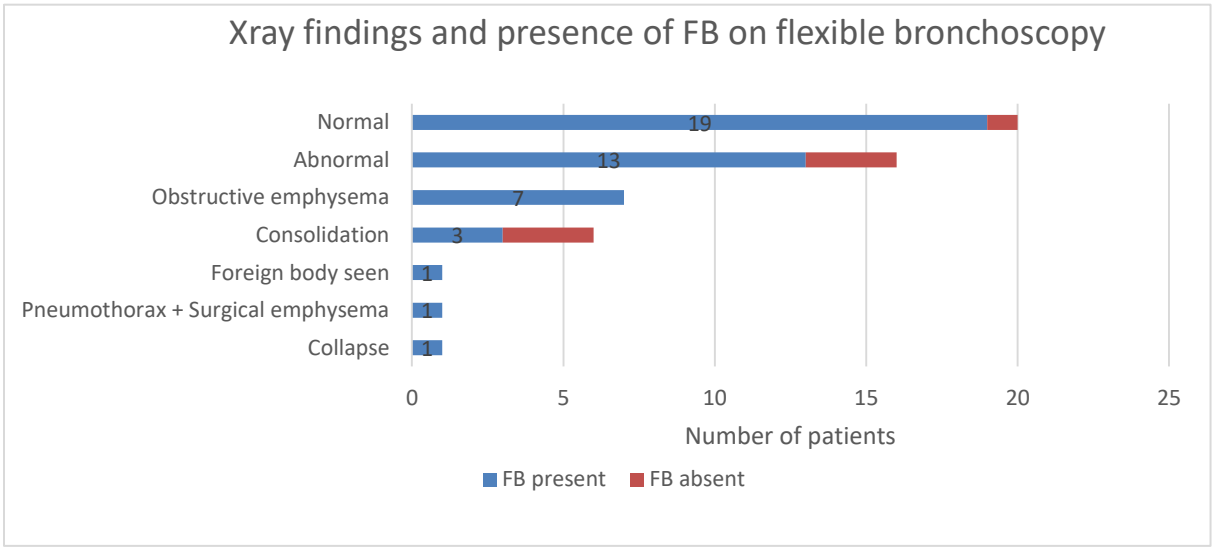

FIG-39: X RAY FINDINGS AND FB ON FLEXIBLE BRONCHOSCOPY

Among 32 patients with foreign body, 19 had normal Xray and the rest 13 had abnormal Xray, among which, 7 had Obstructive Emphysema. (p- value- 0.075) by Fischers exact test.

TABLE-19: DURATION OF SYMPTOMS AND X RAY CHANGES.

	ABNORMAL X-RAY	NORMAL X RAY	P-VALUE*	ODDS RATIO (95% CI)
DURATION MORE THAN 3 DAYS	11 (34.4%)	2 (6.3%)	<0.001	46.75 (5.7 - 382.4)
DURATION LESS THAN 3 DAYS	2 (6.3%)	17 (53.1%)		

* Chi-square test

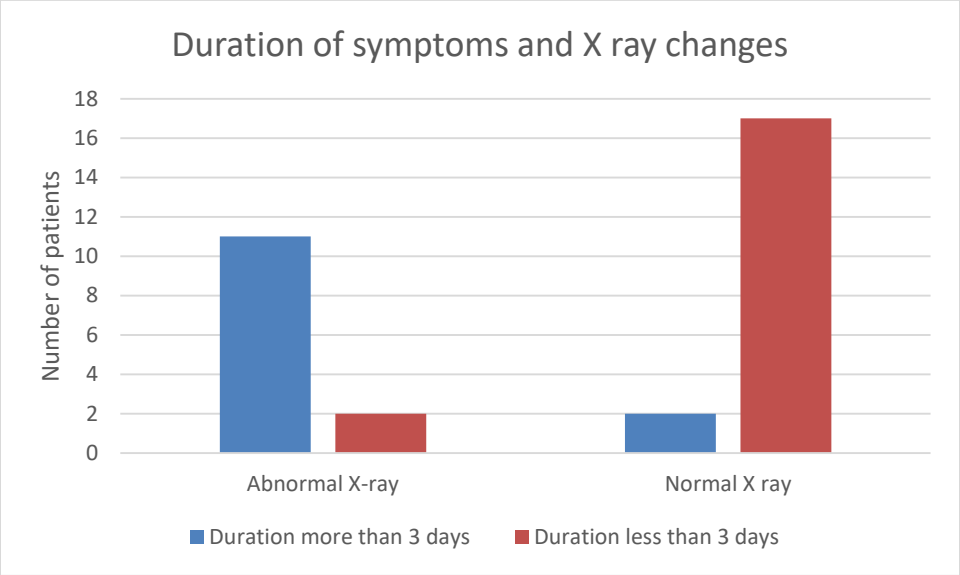

FIG-40: DURATION OF SYMPTOMS AND X RAY CHANGES

Among 13 patients with foreign body who presented after 3 days of symptoms, 11 had abnormal X ray and 2 had normal X ray and among 19 patients who presented within 3 days of symptoms, 17 had normal Xray and 2 had abnormal Xray. (p- value <0.001)

DISCUSSION

A hospital based prospective cross sectional study was conducted on 36 patients over the period from November 2019 to August 2021 to know the role of flexible bronchoscopy in early diagnosis and management of laryngotracheobronchial foreign bodies and to show that flexible bronchoscopy plays a major role in early diagnosis of foreign bodies of the airway in suspected cases, also in reducing negative rigid bronchoscopies and the associated complications. Laryngotracheal foreign bodies in children can lead to serious and sometimes fatal complications due to delayed diagnosis and less index of suspicion.

AGE AND GENDER INCIDENCE

In the present study of 36 patients, 24 (66.67%) were males and 12 (33.33%) were females. Male to female ratio is 2:1. The age of patients ranged from 4 months to 56 years of age, median age was 2.25 years (IQR 1.06-3 years). The most commonly affected age group was 1 to 3 years, which included 24 (66.67%) patients. This was followed by patients belonging to the age group of (3 to 7 years) with 4(11.11%) patients and then (age <1 year) group had 3 (8.33%) patients.

Righini CA *et al.* [1] conducted a study on the "diagnostic value of flexible bronchoscopy in the initial investigation of children with suspected foreign body aspiration" and the study included 70 cases of which 44 were males and 26 were females with sex ratio 1.9:1 and the median age was 2 years.

Bannerjee *et al.* [3] conducted a study on "laryngotracheobronchial foreign bodies in children" and the study included 223 patients, of which, 157 were males and 66 were females with a sex ratio of 2.4:1. The commonest age group was (1-3)years which included 107 patients.

Tokar *et al.* [12] conducted a study on "Tracheobronchial foreign bodies in children: importance of accurate history and plain chest radiography in delayed presentation" and the study included 214 children of which 122 were males and 92 were females with a sex ratio of (1.3:1). The most common age group involved was 1-3 years.

The pathophysiology of FB inhalation is attributed to factors like lack of molar tooth, necessary for proper grinding of food, inadequate chewing of food, tendency of children to explore the environment by placing objects in their oral cavity, underdeveloped neuromuscular mechanisms for swallowing, immaturity of the coordination between swallowing and respiration, and often children play, run around or jump and laugh while eating and do not pay attention on chewing and swallowing, which can lead to aspiration.

HISTORY OF ASPIRATION:

Among 36 patients in our study, 16 gave positive history of foreign body aspiration, 3 gave doubtful history and 17 gave negative history of foreign body aspiration.

In a study conducted by Banerjee *et al.* [3], 163(73.1%) patients gave positive history of aspiration, another 42 patients had suspicion of foreign body and 18 patients gave negative history.

Tan *et al*. conducted a study on 135 patients, of which, 17(12.5%) cases gave negative history of foreign body aspiration. Swanson et al in his study found that 62(87%) children had an initial history of foreign body aspiration.

Chatterjee *et al.*[10] commented that if history of aspiration is present, it may be helpful but it is surprisingly often absent. Any patient who had a choking episode or gagged or had a bout of coughing during eating must have a bronchoscopy before the possibility of foreign body can be ruled out. Patients may present so late that the initial symptoms have been forgotten, hence delaying the diagnosis.

SYMPTOMS:

Among 36 patients, all 36 had cough which was the commonest presentation, followed by noisy breathing in 21 patients and then choking in 16 patients. Breathlessness was a presenting symptom in only 7 patients. And 3 patients also gave history of vomiting.

This is comparable to the study of Tokar et al in which he found that cough was the commonest symptom in 86.4% followed by choking in 64% and wheezing in 29.4%.

In a similar study done by Naragund *et al.*[14] found that most common presenting symptom was coughing and wheezing in 20 (90.9%) cases, followed by breathlessness in 16 (72.7%) cases. History of choking following foreign body aspiration was present in 12 (54.54%) cases.

Banerjee *et al.*[3] in his study found that the commonest presenting symptom was choking (87.4%) followed by intractable cough (82.5%), respiratory distress in 49.4%, audible wheeze in 24.2%, stridor was present in (7.1%) .

DURATION OF SYMPTOMS:

In our study, among 36 patients, 13(36.1%) have presented within 1 day, followed by 7(19.4%) who presented by (1-3) days of symptoms, followed by 6(16.7%) who presented by (3-7) days of symptoms and another 5(13.9%) who presented by (7-15) days of symptoms and the rest 5 patients after 15 days of symptoms.

Righini *et al.*[1] in his study found that 30 (43%) presented within 24 hours of onset of respiratory signs, 25 (36%) between 24 hours and and 7 days, whereas 15 (21%) patients presented 7 days later.

Banerjee *et al.*[3] in his study found that only 116 (52.0 per cent) patients reported within 24 hours of the accident.The earliest that a patient was brought was within 30 minutes of aspiration. The longest delay was seven years where a metallic stud was impacted in lower lobe bronchus leading to bronchiectasis.

Naragund *et al*. [14] in his study found that only 3 (13.6%) patients were brought to the hospital within 24 h of aspiration. Most cases were not emergencies and consulted the hospital between 8 and 15 days and more than a month seen in 5 cases (22.7%) each. The earliest time took by patient to reach the hospital was 4 h while the longest time taken was 6 months.

The delay in seeking medical assistance can be because the parents may be unaware of aspiration and due to misdiagnosis at initial presentation with symptoms of upper respiratory tract infections.

SIGNS:

In our study of 36 patients, unilateral rhonchi/crepts was the commonest sign seen in 33(91.7%) patients, followed by reduced air entry on one side in 30(83.3%) patients, followed by Dyspnoea in 16 (44.4%) patients. Stridor was present in 3(8.3%) patients and 1(2.8%) patient had developed surgical emphysema.

One patient presented with breathlessness and was irritable. Xray was done which showed features of pneumothorax and surgical neck emphysema. Foreign body (piece of peanut) was found in left lower lobe bronchus on flexible bronchoscopy which was obstructing the bronchial lumen and led to rupture of emphysematous bulla and patient developed pneumothorax and surgical neck emphysema. Foreign

body was removed using rigid bronchoscopy. And surgical emphysema improved over next few days.

Naragond *et al*. [14] in his study found that most of the patients had diminished or absent breath sounds on the affected side which was seen in 16 cases (72.7%), followed by rhonchi in 12 cases (54.5%)

Cohen *et al*. [7] in his study found that localized areas of decreased lung sounds and wheezes were significantly more common in the children with FB inhalation compared with the children with normal bronchoscopy findings
(decreased lung sounds, 57% vs 15%; wheezes, 43% vs 17%).

Shivakumar *et al*.[13] in his study found that decreased air entry 83(79.02%) and unilateral wheeze 66(62.83%) were the common respiratory signs, in cases where foreign body aspiration was confirmed after bronchoscopy, whereas wheeze and rales were the common respiratory signs in cases where foreign body aspiration was ruled out after bronchoscopy.

X-RAY FINDINGS:

Out of 36 patients in our study, 20(55.6%)had a normal X ray, 7(19.4%) had obstructive emphysema, 6(16.7%) had Pneumonitis. 1(2.8%) patient had lung collapse and another 1(2.8%) patient had Pneumothorax with Surgical emphysema.

One patient presented with history of foreign body (plastic whistle) aspiration. On examination, patient had wheeze and reduced air entry on right side. Xray was done, in which, foreign body was seen in the abdomen. Due to suspicion of aspiration of part of whistle, flexibe bronchoscopy was done, which showed foreign body in right main bronchus, and was removed by rigid bronhoscopy. Hence, in cases where foreign body is seen in abdomen on X ray, flexible bronchoscopy should not be overlooked, as part of the foreign body could be aspirated as happened in this case.

Shivakumar *et al.*[13] in his study found that radioopaque foreign body was present in 4 cases.Obstructive emphysema was seen in 49.50% and atelectasis in 22.85% of cases where foreign body aspiration was confirmed after bronchoscopy

Naragund *et al.*[14] in his study found that Chest X-ray PA view showed obstructive emphysema as commonest finding in 12 cases (54.5%) because of more number of vegetative foreign bodies in present study (77.3%). 7 cases (31.82%) showed consolidation/ homogenous opacity. Radio opaque foreign body was made out only in 3 cases (13.6%). 2 Cases (9.1%) had normal chest X-ray finding.

Banerjee *et al.*[3] commented that the sequelae of aspiration-like atelectasis, obstructive emphysema, etc., were better appreciated in the case of organic substances.

TYPE OF FOREIGN BODY ASPIRATED:

Among 32 patients with foreign body in our study, the commonest foreign body aspirated was peanut by 11(34.4%) patients followed by coconut piece in 3(9.4%). Among 32 foreign bodies, 29 were organic and 3 were inorganic.

Shivakumar *et al.*[13] in his study found that groundnut was the most common foreign body as seen in 35 cases (33.32%). Organic foreign bodies constituted 91.4%. Eleven foreign bodies were nonorganic in nature.

Naragund *et al.*[14] in his study found that vegetative foreign body was commonest type, which was found in 17 cases (77.3%) and remaining 05 cases (27.3%) had non vegetative foreign bodies. Groundnut was commonest vegetative foreign body found in 06 cases (27.3%). Non vegetative foreign bodies accounted for 4.5%.

In this study, organic foreign bodies (67.4%) remained the most important type.Various types of nuts (40.7%) topped the list of aspirated foreign bodies. The most common non organic foreign bodies were plastic objects and accounted for 10 (7.4%) of all aspirated foreign bodies.

SITE OF IMPACTION:

In our study, the commonest site of impaction was Right main bronchus 16(50%) followed by left main bronchus 13(40.6%) and 1(3.1%) in trachea. The foreign body that was lodged in trachea was a tamarind seed but was not able to remove it out through the glottic space as it had swolled up. Hence, tracheostomy was done and foreign body was removed.

In the study by Naragund *et al.*[14], it was found that most common site of foreign body lodgment was in right main bronchus in 50% cases (n = 11), followed by left main bronchus in 45.5% (n = 10) and 4.5% (n = 1) in trachea.

In the study by Shivakumar *et al.*[13], it was found that 65 foreign bodies were lodged in the right bronchial tree and 36 were in left bronchial tree. In only 4 cases foreign bodies were lodged in the trachea.

In a similar study by Tan *et al.*[8], majority (73 or 53.7%) of the foreign bodies were situated in the right bronchial tree and 52 (38.2%) in the left. Nine (6%) foreign bodies were in the trachea at different levels and two (1.4%) were in the larynx.

ASSOCIATIONS:

In our study, association between history of foreign body aspiration and finding on flexible bronchoscopy was analysed and found that there is no statistically significant association between them. (p-value: 0.162) and the negative predictive value was only 23.5%. Hence, in cases where there is no history of foreign body aspiration, there shoud be high index of suspicion regarding presence of foreign body and flexible bronchoscopy should be done to rule out if any.

In our study, association between symptoms in patients and foreign body on flexible bronchoscopy was studied and found that cough, noisy breathing were the commonest symptoms. Choking history was given by 16(50%) patients among those who had a positive foreign body and the rest 16 didn't give history of choking even though they had a positive foreign body. The negative predictive value of the symptom of choking was only 20% and the sensitivity was only 50%. Hence based on symptoms alone the possibility of foreign body should not be neglected and always a high index of suspicion should be there if symptoms are not improving with conventional medical management and flexible bronchoscopy should be done to rule out any foreign body.

In our study, association between signs in patients and foreign body on flexible bronchoscopy was studied and found that unilateral rhonchi/crepts and reduced air entry on one side were the commonest signs followed by dyspnoea. Hence in such cases foreign body bronchus should be suspected and patient should be subjected to flexible bronchoscopy to see for foreign body and if present removal by rigid bronchoscopy should be done without delay. This will help in preventing the complications associated.

In our study among 36 patients, association between X ray findings and foreign body on flexible bronchoscopy was studied. It was found that 19(52.8) people had normal

X ray and 13 had abnormal X ray with p-value of 0.075. Hence there is no statistically significant association. In patients who doesn't give history of foreign body aspiration with a normal X ray, foreign body can't be ruled out until flexible bronchoscopy is done as X ray changes start developing in patients after 24-48 hours of aspiration.

In our study, association between duration of symptoms and X ray changes were studied and found that abnormal X ray findings were present in 11(34.4%) patients who seeked medical help after 3 days of symptoms and in 2(6.3%) patients who presented within 3days. X rays taken at the onset of symptoms can be deceiving as they appear normal even in the presence of foreign body. (p-value<0.001) Hence it is statistically significant.

No patients in our study developed any complications intraoperatively while removing foreign body or post operatively as the duration of rigid bronchoscopy was shortened (within 20 minutes) because a flexible bronchoscopy was done first and the site, size and nature of foreign body was identified which helped in faster removal of foreign body without any complications. Flexible bronchoscopy also helped in avoiding rigid bronchoscopies in cases where foreign body was not found on flexible bronchoscopy, thus reducing the complications.

CONCLUSION

Foreign body aspiration in children is overlooked by General Practitioners and Pediatricians because of the varied clinical presentation and absence of definite positive history of aspiration in nearly half of the patients.

Only on taking meticulous history by asking repeatedly the parents and relatives, recent or past history of choking is available retrospectively. The occurrence of foreign body aspiration in children is much more than what it is thought to be.

Foreign body in the lower respiratory tract may present in a variety of disguises ranging from stridor, dry cough, wheezing, chronic non resolving pneumonia or chronic recurrent lower respiratory tract infection. There are no specific features to pin point the diagnosis of foreign body aspiration. Most of the times, the chest X-ray will be nomal and a few times the clinical findings may be absent except for features suggestive of lower respiratory tract infection.

The foreign body of respiratory tract could only be ruled out by doing flexible bronchoscopy in all suspected cases and if it turns positive, then go rigid bronchoscopy and removal of the foreign body.

Bronchoscopy is not a dangerous procedure in the present era with ventilating bronchoscopes, fiber optic illumination technique and good anesthetic set up. By doing a flexible bronchoscopy first, the site, size and nature of foreign body is noted. Also any granulation, mucosal edema, pooling of secretions around the foreign body are noted and addressed. Based on the site, size and nature of foreign body, appropriate forceps is chosen for removal of foreign body using rigid bronchoscope,

which helps to reduce the duration of the procedure and hence, the complications associated.

Once foreign body is removed, again a second look into the bronchial tree shoud be done to see for any retained bits of the foreign body or a second foreign body or any retained secretions, which has to be removed.

There should be no hesitation in doing bronchoscopy when there is even the slightest suspicion of a foreign body in the respiratory tract as it happens to be one of the most rewarding surgeries.

SUMMARY

A hospital based Cross sectional study was done on 36 patients with history or suspicion of foreign body aspiration to know the role of flexible bronchoscopy in early diagnosis and management of laryngotracheobronchial foreign bodies.

- The present study includes patients ranging from 4 months to 56 years of age, median age was 2.25 years (IQR 1.06-3 years). The most commonly affected age group was 1 to 3 years, which included 24 (66.67%) patients. This was followed by patients belonging to the age group of 3 to 7 years and less than 1 year with 4(11.11%) and 3 (8.33%) patients in each group respectively.

- Out of the 36 patients in this study, 24 (66.67%) were males and 12 (33.33%) were females. Male to female ratio is 2:1.

- Among 36 patients, 16(44.4%) gave positive history of foreign body aspiration, 3(8.3%) gave doubtful history and 17(47.2%) gave negative history of foreign body aspiration.

- Among 36 patients, all 36(100%) had cough which was the commonest presentation, followed by noisy breathing in 21(58.3%) patients and then choking in 16(44.4%) patients. Breathlessness was a presenting symptom in only 7(19.4%) patients. And 3(8.3%) patients also gave history of vomiting.

- Among 36 patients, 13(36.1%) have presented within 1 day, followed by 7(19.4%) who presented by 3 days of symptoms, followed by 6(16.7%) who presented within a week of symptoms.

- Unilateral rhonchi/crepts was the commonest sign seen in 33(91.7%) patients, followed by reduced air entry on one side in 30(83.3%) patients, followed by Dyspnoea in 16 (44.4%) patients. Stridor was present in 3(8.3%) patients and 1(2.8%) patient had developed surgical emphysema.

- Out of 36 patients, 20(55.6%)had a normal X ray, 7(19.4%) had obstructive emphysema, 6(16.7%) had Pneumonitis. 1(2.8%) patient had lung collapse and another 1(2.8%) patient developed Pneumothorax with Surgical emphysema.

- Among 32 patients, the commonest foreign body aspirated was peanut by 11(34.4%) patients followed by coconut piece in 3(9.4%).Both organic and inorganic foreign bodies were aspirated. 29 were organic and 3 were inorganic.

- Commonest site of impaction was Right main bronchus 16(50%) followed by left main bronchus 13(40.6%).

- Among 36 patients, 16 gave positive history of foreign body aspiration, 3 gave doubtful history and 17 gave negative history of foreign body aspiration. On flexible bronchoscopy foreign body was present in all 16(44.4%) of positive history group, 3(8.3%) of doubtful history group and 13(36.11%) of negative history group. On flexible bronchoscopy, foreign body was absent in 4(11.11%) patients of negative history group.

- Among 32 patients with foreign body on flexible bronchoscopy, the commonest presentation was cough in 32 patients followed by noisy breathing in 21 patients.

- Among 32 patients who had positive foreign body on flexible bronchoscopy, 29 had unilateral rhonchi/ crepts, 28 had air entry less on one side, which was the commonest finding on clinical examination.

- Among 32 patients with foreign body, 19 had normal Xray and the rest 13 had abnormal Xray, among which, 7 had Obstructive Emphysema. (p- value- 0.075) by Fischers exact test.

- Among 13 patients with foreign body who presented after 3 days of symptoms, 11 had abnormal X ray and 2 had normal X ray and among 19 patients who presented within 3 days of symptoms, 17 had normal Xray and 2 had abnormal Xray. (p- value <0.001)

- From this study, we came to the conclusion that foreign body in the airway can be present even in the absence of history of aspiration and with normal X ray findings. Hence, if there is even a slight suspicion of foreign body, flexible bronchoscopy should be done and if foreign body present, it should be removed promptly.

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ANNEXURE-I

ETHICAL CLEARANCE CERTIFICATE

IEC/NO.09/2021
Date- 22/01/2021

B.L.D.E. (DEEMED TO BE UNIVERSITY)

(Declared vide notification No. F.9-37/2007-U.3 (A) Dated. 29-2-2008 of the MHRD, Government of India under Section 3 of the UGC Act, 1956)

The Constituent College

SHRI. B. M. PATIL MEDICAL COLLEGE, HOSPITAL AND RESEARCH CENTRE

INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

The Institutional ethical committee of this college met on 11-01-2021 at 11 am to scrutinize the synopsis of Postgraduate students of this college from Ethical Clearance point of view. After scrutiny the following original/corrected and revised version synopsis of the Thesis has been accorded Ethical Clearance

Title: Role offlexible bronchoscopy In early diagnosis and management of laryngotrachheobronchial foreign bodies

Name of PG student: Anuja M Panicker, Department of E.N.T

Name of Guide/Co-investigator: Dr H T Lathadevi, Professor & HOD of E.N.T

DR .S.V.PATIL
CHAIRMAN, IEC
Institutional Ethical Committee
B L D E (Deemed to be University)
Shri B.M. Patil Medical College,
VIJAYAPUR-586103 (Karnataka)

Following documents were placed before Ethical Committee for Scrutinization:

1. Copy of Synopsis / Research project
2. Copy of informed consent form
3. Any other relevant documents.

ANNEXURE-II

PROFORMA

1) NAME: CASE NO:

2) AGE: IP NO:

3) SEX: DOA:

4) RELIGION: DOS:

5) OCCUPATION: DOD:

6) RESIDENCE:

1) CHIEF COMPLAINTS:

2) HISTORY OF PRESENTING ILLNESS:

- Aspiration of foreign body

  Absent

  Present

What was the foreign body

- Cough

  Absent

  Present Dry

  Productive

  Continuous

  Intermittent

  Started on aspiration or subsequently

- Cyanosis

  Absent

  Present Lasted for-

  Appeared on aspiration or subsequently

- Choking

  Absent

  Present lasted for-

  Started on aspiration or subsequently

- Breathlessness or shortness of breath

  Absent

Present started on aspiration or subsequently lasted for

- Vomiting

  Absent

  Present Food material

  Projectile

- Hoarseness of voice

  Absent

  Present on aspiration or subsequently

- Heamoptysis

  Absent

  Present on aspiration or subsequently

  Amount

- Other complaints

9) PAST HISTORY:

History of similar complaints or attack in the past.

History suggestive of bronchial asthma

History suggestive of recurrent respiratory tract infection.

History of not able to thrive.

10) FAMILY HISTORY:

History suggestive of bronchial asthma

History suggestive of tuberculosis.

11) PERSONAL HISTORY:

Diet

Sleep

Appetite

Bowel and bladder

Developmental milestones

12) IMMUNISATION HISTORY:

BCG, DPT, Measles, Polio,TT

13) GENERAL PHYSICAL EXAMINATION:

Pallor:	Present/Absent
Icterus:	Present/Absent
Clubbing:	Present/Absent
Generalized Lymphadenopathy:	Present/Absent
Build:	Poor/Medium /Well

Nourishment: Poor / Medium / Well

PR:

BP:

Respiratory rate, rhythm, volume:

-Stridor absent / present

Mild moderate/severe

-Tracheal thud

Absent/ present

Cyanosis absent / present

Dyspnoea mild/ moderate/ severe

Fever

Wheezing

14) OTHER SYSTEMIC EXAMINATION:

- RESPIRATORY SYSTEM

Inspection:

1.Shape of chest : Normal/ pigeon shaped/ barrel shaped

2. Respiratory movements:

Character:

Equality:

3. Accessory muscles of respiration : inactive/ active

4. Position of mediastinum: normal/ shifted

Palpation:

Equality of movement of chest wall

Tactile vocal fremitus

Percussion:

Anteriorly:

Posteriorly:

Axilla :

Auscultation:

1. Breath sounds

Normal

Diminished Rt Upper / Lower

Lt Upper/ Lower

Type of breath sounds- Vesicular

Bronchial

Bronchovesicular

2. Added sounds: Rales/ Crepitations Rt: Upper/ Lower

Lt: Upper/ Lower

Rhonchi Rt

Lt

Rub Rt

Lt

3. Vocal resonance: Equal

Decreased Rt Upper/ Lower

Lt Upper/ Lower

Increased Rt Upper/ Lower

Lt Upper/ Lower

- CARDIOVASCULAR SYSTEM:

Heart sounds: S1 and S2

Murmurs: absent / present

- CENTRAL NERVOUS SYSTEM:

Higher functions

Cranial nerves

Motor system

Reflexes

- PER ABDOMEN EXAMINATION:

Liver/Spleen/Other

15) INVESTIGATION:

BLOOD ROUTINE:

RBS, UREA, CREATININE, SEROLOGY

CHEST X-RAY: PA VIEW AND LATERAL VIEW

RADIOLOGY: CHEST X RAY

- Normal
- Obstructive emphysema
- Pneumonia
- Atelectasis
- Radio opaque foreign body
- Pneumomediastinum
- Pleural effusion
- Pneumothorax
- Subcutaneous emphysema
- Pneumonitic changes
- Increased bronchovascular markings

FLEXIBLE BRONCHOSCOPY

Performed under Local anesthesia

Performed Immediately

Within 48 hours

Later 48 hours to 1 week

1 week – 1 month

Flexible Bronchoscopic findings: Secretions

Foreign body

Granulations

Pus

RIGID BRONCHOSCOPY

Anesthesia used for:

Induction

Maintenance

Muscle relaxant

Bronchoscope: size used – 3.5,4,5,6,7

Attempts taken

Time required for the procedure

Rigid Bronchoscopic findings: Secretions

Foreign body

Granulations

Pus

Nature of foreign body:

Vegetative

Non vegetative

Location of the foreign body:

Right side bronchus

Left side bronchus

Right and left bronchus

Trachea

Larynx

Other sites.

COMPLICATIONS OF BRONCHOSCOPY:

- Nil
- Haemorrhage
- Laryngeal oedema
- Tracheobronchial tear

TREATMENT GIVEN:

- Emergency treatment
- Post operative

  Antibiotics

  Bronchodilators

  Steroids

  Others

- Chest Physiotherapy

DISCHARGED

Same day

After 24 hours

Later

16) FINAL DIAGNOSIS:

17) SURGERY: **Intra operative findings**:-

18) INFERENCE:

19) COMMENTS:

ANNEXURE-III

INFORMED CONSENT FORM

BLDE (Deemed to be university) SHRI B. M. PATIL MEDICAL COLLEGE HOSPITAL AND RESEARCH CENTRE, VIJAYAPURA- 586103

TITLE OF THE PROJECT

ROLE OF FLEXIBLE BRONCHOSCOPY IN EARLY DIAGNOSIS AND MANAGEMENT OF LARYNGOTRACHEOBRONCHIAL FOREIGN BODIES

PG STUDENT - Dr. ANUJA M PANICKER
DEPARTMENT OF
OTORHINOLARYNGOLOGY

PG GUIDE - Dr. H T LATHADEVI
PROFESSOR AND HOD
DEPARTMENT OF
OTORHINOLARYNGOLOGY
SHRI B. M. PATIL MEDICAL COLLEGE
HOSPITAL AND RESEARCH CENTRE,
VIJAYAPUR, KARNATAKA– 586103

All aspects of this consent form are explained to the patient in the language understood by him/her.

1) PURPOSE OF RESEARCH:

I have been informed about this study. I have also been given a free choice of participation in this study.

2) PROCEDURE:

I am aware that in addition to routine care received I will be asked series of questions by the investigator. I have been asked to undergo the necessary investigations and treatment, which will help the investigator in this study

3) RISK AND DISCOMFORTS:

I understand that I may experience some pain and discomfort during the examination or during my treatment. This is mainly the result of my condition and the procedure of this study is not expected to exaggerate these feelings that are associated with the usual course of treatment.

4) BENEFITS:

I understand that my participation in this study will help to the patients survival and better outcome.

5) CONFIDENTIALITY:

I understand that the medical information produced by this study will become a part of Hospital records and will be subject to the confidentiality and privacy regulation. Information of a sensitive personal nature will not be a part of the medical records, but will be stored in the investigator's research file and identified only by a code number. The code-key connecting name to numbers will be kept in a separate location.

If the data are used for publication in the medical literature or for teaching purpose, no name will be used and other identifiers such as photographs and audio or videotapes will be used only with my special written permission. I understand that I may see the photographs and videotapes and hear the audiotapes before giving this permission.

6) REQUEST FOR MORE INFORMATION:

I understand that I may ask more questions about the study at anytime.

Dr. ANUJA M PANICKER is available to answer my questions or concerns. I understand that I will be informed of any significant new findings discovered during the course of the study, which might influence my continued participation.

If during the study, or later, I wish to discuss my participation in or concerns regarding this study with a person not directly involved, I am aware that the social worker of the hospital is available to talk with me. A copy of this consent form will be given to me to keep for careful reading.

7) REFUSAL OR WITHDRAWAL OF PARTICIPATION:

I understand that my participation is voluntary and that I may refuse to participate or may withdraw consent and discontinue participation in the study at any time without prejudice to my present or future care at this hospital. I also understand that DR. ANUJA M PANICKER may terminate my participation in the study after she has explained the reasons for doing so and has helped arrange for my continued care by my own physician or physical therapist, if this is appropriate.

8) INJURY STATEMENT:

I understand that in the unlikely event of injury to me resulting directly from my participation in this study, if such injury were reported promptly, the appropriate treatment would be available to me, but no further compensation would be provided. I understand that by my agreement to participate in this study I am not waiving any of my legal rights.

I have explained to _____the purpose of the research, the procedures required and the possible risks and benefits to the best of my ability in patient's own language.

_____ _____

Dr. ANUJA M PANICKER Date

(Investigator)

STUDY SUBJECT CONSENT STATEMENT

I confirm that DR. ANUJA M PANICKER has explained to me the purpose of research, the study procedures that I will undergo, and the possible risks and discomforts as well as benefits that I may experience in my own language. I have read and I understand this consent form. Therefore, I agree to give consent to participate as a subject in this research project.

_____ _____

Participant / Guardian Date

_____ _____

Witness to signature Date

ANNEXURE-IV

KEY TO MASTER CHART

I. HISTORY OF ASPIRATION OF FOREIGN BODY

1. Positive
2. Doubtful
3. Negative

II. DURATION OF SYMPTOMS

1. <1 Day
2. 1-3 Days
3. 3-7 Days
4. 7-15 Days
5. 15-30 Days
6. > 30 Days

III. SYMPTOMS

1.Cough
2.Choking
3.Vomiting
4.Breathlessness
5.Noisy breathing

IV SIGNS

1.Dyspnoea
2. Stridor
3. Air entry equal and bilaterally reduced

4. Air entry reduced on one side
5. U/L Rhonchi and/or crepts
6. B/L Rhonchi and/or crepts
7. Surgical Emphysema

V. X-RAY FINDINGS

1. Normal
2. Collapse
3. Consolidation/ pneumonitis
4. Obstructive emphysema
5. Pneumothorax + Surgical Emphysema
6. Foreign body seen

VI. SITE OF IMPACTION OF FOREIGN BODY

1.Larynx
2.Trachea
3.Right main bronchus
4.Right lower lobe bronchus
5.Left main bronchus
6.Left lower lobe bronchus

VII. TYPE OF FOREIGN BODY ASPIRATED

1.Peanut

2.Cashewnut

3.Bengal Gram

4.Tamarind Seed

5.Toor Dal

6.Coconut Piece

7.Grass Weed

8.Plastic Pen Tip

9.Wheat Seed

10. Whistle

11. Sitaphal seed

12. Corn seed

13. Beetel nut

14. Mutton piece

VIII. ON FLEXIBLE BRONCHOSCOPY, FOREIGN BODY

1. Present

2. Absent

ABBREVIATIONS IN MASTERCHART

HIS- HISTORY

DUR- DURATION

SYMP- SYMPTOMS

FB- FOREIGN BODY

ANNEXURE-V

MASTERCHART

SL.NO	NAME	AGE/SEX	HIS	DUR	SYMP	SIGNS	X RAY	FB FOUND	TYPE OF FB	FB ON FLEXIBLE BRONCHOSCOPY
1	Samarth	4yr/M	1	1	1	4,5	1	3	1	1
2	Veeresh	3yr/M	3	4	1,5	4,5	3	3	1	1
3	Karthik	10mn/M	3	4	1	5	3	_	_	2
4	Spoorthi	3yr/F	1	4	1,2,5	1,4,5	4	5	1	1
5	Soumya	3yr/F	3	3	1	1,4,5	1	5	7	1
6	Sanvi	15mn/F	3	5	1	1,5	3	_	_	2
7	Sidharth	2.5yr/M	3	5	1,5	4,5	4	3	1	1
8	Uday	2yr/M	2	5	1,2,5	1,4,5	2	5	13	1
9	Sanvi	1yr/F	1	3	1,2,5	4,5	1	3	6	1
10	Ajij	8mn/M	3	2	1,5	1,4,5	1	5	7	1
11	Binod	4mn/M	3	2	1	4,5	1	_	_	2
12	Rohan	5yr/ M	1	1	1,2,5	4,5	1	3	4	1
13	Pratham	1yr/M	3	4	1,4	1,4,6	3	5	6	1
14	Akash	8yr/M	1	1	1,2,5	4,5	1	3	1	1
15	Prateek	1yr/M	2	2	1,4,5	1,5,6,7	5	6	1	1
16	Husenabi	2yr/F	3	5	1	1,4,5	3	_	_	2
17	Hussain	56yr/M	1	1	1,2,3,4,5	1,2,3,6	1	1	14	1
18	Shrushti	7yr/F	1	1	1,2,4,5	1,2,4,5	6	5	10	1
19	Aiswarya	2.5yr/F	3	6	1,4	4,5	3	5	1	1
20	Jeewan	2yr/M	1	1	1,2,5	4,5	1	3	1	1
21	Prasanth	2yr/M	1	2	1,2	4,5	1	3	2	1
22	Rahul	18mn/M	1	1	1,2,5	1,4,5	1	5	1	1
23	Sanvi	1yr/F	1	1	1,2,5	1,4,5	1	3	6	1
24	Sangmsh	2yr/M	1	1	1	4,5	1	5	8	1
25	Veeresh	1yr/M	2	2	1,2,4	1,4,5	1	5	11	1
26	Shivaji	3yr/M	3	3	1,5	4,5	4	5	12	1
27	Parvathi	2.5/F	3	3	1,5	4,5	4	5	2	1
28	Mahadev	3yr/M	3	4	1,5	4,5	4	3	1	1
29	Atik	1yr/M	1	1	1,2,3,4,5	1,2,3,4,6	1	2	4	1
30	Meghna	5yr/F	1	1	1,2,5	4,5	1	5	13	1
31	omangoud	13yr/M	1	1	1,2,3	1,4,5	1	3	10	1
32	Ananya	3yr/ F	1	1	1,2,5	1,5	1	3	1	1
33	Amruth	2yr/M	3	2	1	4,5	1	3	5	1
34	Shanmug	2yr/M	3	3	1	4,5	4	3	9	1
35	Tasmiya	3yr/F	3	2	1	4,5	1	3	3	1
36	Dhanajay	10yr/M	3	3	1,5	4,5	4	3	11	1