RADIOLOGOCAL ANATOMY AND TECHNIQUES IN THE THORAX

Dr. J. Reynolds – Birmingham Heartlands Hospital.

Understanding the cross-sectional anatomy of the thorax aids the understanding of features on the plain chest radiograph. Both computed tomography (CT) and magnetic resonance imaging (MRI) can be used to examine the chest though CT will be used in this lecture as it is the technique with which people are most familiar. The following are some of the more important points of anatomy: -

1. The right main bronchus has a more vertical course than the left main bronchus. The right upper lobe bronchus arises more proximally than the left upper lobe bronchus.
2. The right main bronchus and its divisions into right upper lobe bronchus and bronchus intermedius are outlined posteriorly by lung. The posterior walls of these structures therefore appear as a thin line on the lateral chest radiograph or on CT. If soft tissue abuts the posterior aspects of these structures then it is likely to represent pathology such as tumour or lymphadenopathy.
3. The right pulmonary artery passes anterior to the major bronchi to reach the lateral aspects of the bronchus intermedius and lower lobe bronchus, whereas the left pulmonary artery arches over the left main bronchus and left upper lobe bronchus to descend postero-lateral to the left lower lobe bronchus.
4. Pulmonary veins are similar on the two sides. The superior pulmonary veins are the anterior structures in the upper and mid hilum on both sides. The inferior pulmonary veins run obliquely forward beneath the divisions of each lower lobe artery to enter the left atrium. Because the central portions of the pulmonary arteries are so different on each side, the relationship between major veins and arteries differs. On the right the superior pulmonary vein is separated from the bronchus by the lower division of the pulmonary artery. On the left the superior vein is separated from the lower division of the pulmonary artery by the bronchial tree.
5. The large round shadow seen at the hilum on the lateral chest radiograph is a combination of right pulmonary artery and superior pulmonary vein. The confluence of the inferior pulmonary veins on the lateral view may be mistaken for a lung mass.

The normal pleura cannot be imaged directly with CT, even HRCT, because it cannot be separated from adjacent structures. In normal subjects there is a linear opacity of 1 to 2 mm thickness overlying the intercostal spaces, connecting the inner aspects of the ribs. This opacity, the intercostal stripe, is produced by two layers of pleura, extra-pleural fat, the endothoracic fascia and the innermost intercostal muscle. The intercostal stripe disappears on the inner aspects of the ribs, since at this point it generally consists only of the pleura, extrapleural fat and endothoracic fascia, which are too thin to resolve. Some individuals have prominent extrapleural fat, which is typically visible postero-laterally between the fourth and eighth ribs.

On CT the ascending and descending aorta appear round whereas the aortic arch is seen as a tapering oval that becomes narrower as it gives rise to the arteries of the head, neck and arms. The average diameter of the ascending aorta is 3.5 cm and that of the descending aorta is 2.5 cm.

The main pulmonary artery runs obliquely backward and upward to the left of the ascending aorta. Its average diameter is 2.7 cm. It divides into right and left main branches. The right branch travels more or less horizontally through the mediastinum between the ascending aorta and SVC anteriorly and the bronchial tree posteriorly. The left pulmonary artery arches higher than the right and passes over the left main bronchus to descend posterior to it. For this reason the left pulmonary artery is seen on a higher CT section than the right pulmonary artery and on the chest radiograph the left hilum is typically 1.5 cm higher than the right. The right pulmonary artery is two-thirds the diameter of the main pulmonary artery.

Four named spaces surround the central airways: - the pre-tracheal space, the aorto-pulmonary window, the sub-carinal space and the right para-tracheal space. All four spaces contain lymph nodes that drain the lung and which might become involved with a bronchogenic carcinoma. In addition to these central spaces there are the junction areas, so called because in these areas the

lungs approximate to one another. One lies anterior to the aorta and pulmonary artery and is known as the anterior junction or the pre-vascular space. The other lies posterior to the oesophagus and is known as the posterior junction.

CT series documenting lymph node size are in general agreement. In these series, 95% of normal mediastinal lymph nodes are 10 mm or less in short axis diameter. Nodes in the region of the brachiocephalic veins are
generally smaller with over 95% measuring 5 mm or less whereas nodes in the aorto-pulmonary window, the pre-tracheal and lower para-tracheal spaces are often 6 to 10 mm in short axis diameter. Nodes in the para-cardiac areas rarely exceed 3.5 mm in diameter and are often not visualised in normal subjects. Retrocrural nodes do not normally exceed 6 mm in diameter.

Staging Lung Cancer

Thanks to technological advances a great deal of lung cancer staging can now be performed non-invasively with combination of CT scanning and chest radiography. Positron emission tomography (PET) scanning is not yet widely available in the UK but has great potential due to its ability to provide functional, metabolic information. MRI is not used routinely but is useful in some patients when the CT findings are equivocal.

Both CT and MRI can clearly show the presence of extensive tumour within the mediastinum. Encasement of vital structures such as the oesophagus, trachea or great vessels, or deep penetration of tissue planes is conclusive evidence of a T4 tumour. The CT features of limited mediastinal contact or preserved fat plane are reasonably accurate (< 3 cm, < 90% aorta) at predicting tumour resectability. MRI is of similar value; its multiplanar capability is advantageous only in specific regions. Both techniques are less accurate at identifying T4 disease and irresectability.

A peripheral tumour may transgress the parietal pleura and invade ribs and intercostal muscle. Such localised invasion of the chest wall (T3) is not a contraindication to surgery, but it adversely affects prognosis and alters the surgical technique. Contact with the pleura on CT, even if the pleura is thickened, does not necessarily indicate invasion. The greater the degree of contact and the greater the pleural thickening, the more likely it is that the parietal pleura has been invaded, particularly if the extra-pleural fat plane is obliterated. Both CT and MRI can predict resectable tumours, but cannot distinguish inflammatory chest wall adherence from early invasion. Extensive chest wall invasion can be readily identified with either modality, but such invasion does not necessarily imply inoperability.

CT can be helpful for diagnosing Pancoast or superior sulcus tumours. It may confirm an intrapulmonary mass rather than just pleural thickening. MRI is now regarded as the optimal modality for demonstrating the extent of superior sulcus tumours. This is largely because the coronal and sagittal planes used in MRI are the optimal planes to demonstrate the cupola shape of the chest wall in the apical regions and to show the brachial plexus, subclavian vessels, neural foramina and any bone marrow invasion to advantage. A staging CT scan will, however, still be required.

The most important predictor of outcome in the majority of patients with lung cancer limited to the chest is the presence or absence of involved mediastinal lymph nodes. Surgery is not an option for patients with positive contralateral lymph nodes (N3). Surgery is also considered inappropriate in symptomatic N2 disease. The most extensively validated CT sign of lymph node metastasis is nodal enlargement. CT enhancement characteristics have not proved helpful and low-density necrotic tissue within a node (a useful sign in head and neck cancers) has not proved to be sufficiently frequent to be of value. MRI has not been shown to be reliable in distinguishing benign from malignant nodal disease.

The problem with using size as the only criterion for malignant involvement is that intrathoracic node enlargement has non-malignant causes including TB, sarcoidosis and more importantly, reactive hyperplasia secondary to associated pneumonia and atelectasis. Conversely, microscopic involvement by tumour can be present without causing nodal enlargement. Involvement of normal sized nodes with tumour is more common with central adenocarcinoma than with central

squamous carcinoma.

MRI has potential advantages due to its ability to distinguish flowing blood from soft tissue and its ability to images in the coronal and sagittal planes. However, lower resolution and greater movement artefact creates problems. On MRI a cluster of normal sized lymph nodes could be mistaken for a single enlarged node. Also, calcification is not revealed on MRI so nodes, which on CT would look obviously benign, could look malignant on MRI. In general, MRI has little advantage over CT for imaging mediastinal nodes.

Radionuclide studies, particularly FDG PET (positron emission tomography) offer promise by combining anatomical and functional information. Studies publishes so far are based on relatively small numbers but they have shown consistently greater accuracy for PET compared with CT for the detection and exclusion of nodal metastatic disease.

Summary of Imaging Non-small cell Lung Cancer

CT sensitivity and specificity for mediastinal nodal disease is about 65%, therefore targeted biopsy of enlarged nodes is required.

CT predicts resectable tumours, but is unreliable for identifying inoperable mediastinal invasion.

MRI is comparable with CT as a routine test, but can be useful for solving specific problems.

PET is a promising technique for diagnosing nodal disease but has no proven value for determining the extent of the primary tumour.

Sonography may have a limited role (some centres use endoscopic ultrasound to identify and biopsy enlarged mediastinal nodes).

Patients should not be denied surgery on the basis of indeterminate imaging findings.

Further Reading:

Most of the information for these lecture notes was taken from the following two texts, both of which are highly recommended for further reading:

1. Imaging of Diseases of the Chest, 3rd Edition. Edited by Armstrong P, Wilson AG, Dee P and Hansell DM. Mosby, London 2000. ISBN 0 7234 31663
2. Radiologic Clinics of North America: Lung Cancer. Edited by Claudia I. Henschke. WB Saunders, Philadelphia, May 2000.

PET STAGING OF LUNG CANCER

Mr. P. Guest – University Hospital Birmingham Foundation Trust.

Some of the best evidence for the use of PET scanning is in thoracic oncology.

Draft guidance from NICE, the DOH and the Royal Colleges suggest that:

1. An FDG PET scan should be performed to investigate solitary pulmonary nodule where a biopsy is not possible or has failed.
2. Patients who are staged as candidates for surgery on CT should have an FDG-PET scan to look for involved intrathoracic nodes and distant metastases.
3. Patients who are candidates for radical radiotherapy on CT should have an FDG PET scan

In addition PET is very helpful in differentiating recurrence from post surgical or radiotherapy change. There may be a role in radiotherapy planning, and staging of small cell lung cancer.

I would advise PET scanning in patients being considered for metastectomy of apparently isolated lesions.

There is good evidence of its routine use in the routine pre-operative staging of oesophageal cancer.

This presentation will review the evidence for some of the above recommendations and illustrate the physics and physiological principles for PET scanning, with illustrative examples of normal, benign and malignant findings.

The additional benefit of PET-CT fusion scanners/images will also be illustrated.

References :

1.PET – a strategy for the UK, report of the intercollegiate standing committee on nuclear medicine 2003 : www.rcplondon.ac.uk/pubs/wp_pet.pdf

2.Consultation document DOH July 2004 Gary.Arnold@doh.gsi.gov.uk

3. Draft NICE lung cancer guidelines

4.Rohren E: Clinical Applications of PET in oncology Radiology 2004; 231:305-332

STAGE SPECIFIC SURGICAL INTERVENTION FOR NON-SMALL CELL LUNG CANCER

Mr. D. Waller – Glenfield, Leicester.

This lecture will cover the multidisciplinary management of non-small cell lung cancer. Each stage of the disease will be addressed separately and the following issues will be discussed :

Stage I (T1-2 N0)

In the management of the solitary pulmonary nodule VATS excision biopsy (with intraoperative frozen section) is preferable to preoperative percutaneous biopsy.

In selected stage I tumours Lobectomy may not be the gold standard

In selected stage I tumours VATS lobectomy is the treatment of choice

Stage II (T1-2 N1, T3N0)

En-bloc chest wall resection/reconstruction is mandatory in T3 (chest wall) tumours
Lobe specific systematic lymph node dissection is the recommended method of Intraoperative lymph node management
Adjuvant chemotherapy confers a survival benefit but is not the standard of care.

Stage IIIa (T1-3 N2, T3N1)

N2 positive patients should receive induction chemotherapy.
Only pathologically "downstaged" patients should go on to resection.
Pancoast tumours should receive induction chemoradiotherapy

Stage IIIb (T4 or N3)

T4 satellite lesions should undergo resection.
T4N0 locally invasive tumours may not benefit from surgery.

Stage IV (M1)

Truly Oligometastatic disease may be treated by resection of the primary and isolated metastasectomy

REFERENCES:

ACCP Lung Cancer Guidelines Panel (2003). Diagnosis and Management of Lung Cancer. *Chest* **123**(suppl 1) 1S-338S

Anonymous. (1997). Clinical practice guidelines for the treatment of unresectable non-small-cell lung cancer. Adopted on May 16, 1997 by the American Society of Clinical Oncology. *Journal of Clinical Oncology*, **15,** 2996-3018.

Canadian Lung Oncology Group. (1995). Investigation for mediastinal disease in patients with apparently operable lung cancer. Canadian Lung Oncology Group. *Ann Thorac Surg*, **60,** 1382-9.

Ginsberg, R.J. & Rubinstein, L.V. (1995). Randomized trial of lobectomy versus limited resection for T1 N0 non-small cell lung cancer. Lung Cancer Study Group. *Annals of Thoracic Surgery*, **60,** 615-22; discussion 622-3.

Graham, A.N., Chan, K.J., Pastorino, U. & Goldstraw, P. (1999). Systematic nodal dissection in the intrathoracic staging of patients with non-small cell lung cancer. *Journal of Thoracic & Cardiovascular Surgery*, **117,** 246-51.

McKenna, R.J., Jr., Wolf, R.K., Brenner, M., Fischel, R.J. & Wurnig, P. (1998). Is lobectomy by video-assisted thoracic surgery an adequate cancer operation? *Annals of Thoracic Surgery*, **66,** 1903-8.

Mountain,C.F. (1997). Revisions in the International System for Staging Lung Cancer.*Chest*, **111,**1710-7.

Sedrakyan A, Van derMeulen J, O'Byrne KJ, Prendiville J, Hill J, Treasure T. Postoperative chemotherapy for non-small cell lung cancer : systematic review and meta-analysis. J Thorac Cardiovasc Surg 2004;128:414-9

SURGERY IN TRACHEAL DISORDERS

Professor R. Santosham – Chennai, India.

Tracheal surgery was one of the last subspecialties to develop in the field of Cardiothoracic surgery.

HISTORICAL REVIEW:

Despite the antiquity of tracheostomy, the techniques of tracheal surgery took a long time to establish. Tracheostomy changed little technically, but was soon replaced by endotracheal intubation in general anaesthesia and emergency airway management. The 1960s proved to be a decade in which advances in tracheal surgery quickened.

The major apprehension towards tracheal surgery was due to the notion that cartilage healed poorly when repaired. The Rig Veda, a book on Hindu medicine observed as early as in 2000 B.C that " the trachea can reunite when the cervical cartilages are cut across, provided they are not entirely severed".

Even though Kuster, in 1886 performed the first tracheal resection and anastomosis in humans, the techniques were standardized only in the 1960s. The major inhibitions to tracheal reconstruction were

(1) Suspicion of poor healing of the cartilaginous tissues.
(2) Presumed limits of resection to a maximum of 2 – 4 cm.
(3) Maintenance of safe, continuous and stable ventilation both pre and post operatively.
(4) Less incidence of cases due to traumatic, iatrogenic and inflammatory causes.
(5) Absence of well established ideal prostheses.

Eventually, cumulative clinical experience in the 20^{th} century established that the trachea healed firmly with suture repair after laceration or rupture. A number of successful resections and reconstructions with primary anastomosis were described in the 1950s and early 1960s, most often for shorter, benign lesions such as stricture.

The "2cm rule", which had served to inhibit advances in tracheal surgery, was then challenged by experiments in cadavers & animals. Grillo & colleagues in 1964, reported from autopsy studies in man, that over half of the adult trachea could be resected and continuity reestablished by full mobilization of adjacent strictures.

SURGICAL ANATOMY:

The adult male trachea ranges from 10 to 12 cm and there are usually 2 cartilaginous rings per cm. The trachea extends from the cricoid to the carina. The length and diameter varies according to the size of the individual. The trachea is longer and wider in tall, long necked, thin men and is shorter and narrower in short necked, obese women. Also in young adults the trachea rises to one-half of length in the neck on extension, whereas this does not happen in the elderly.

The strictures which are adjacent to the trachea and should be carefully avoided during reconstruction are

(a) Oesophagus (b) Thyroid isthmus (c) Superior and Recurrent laryngeal nerves
(d) Innominate artery.

The blood supply of the upper part of trachea is derived from the three tracheal branches of inferior thyroid artery and that of the middle and lower parts from the supreme intercostals, subclavian , right internal thoracic and innominate arteries. The blood supply enters the trachea through lateral tissue pedicles in segmental fashion throughout the trachea.

TRACHEAL DISORDERS:

The tracheal lesions which are common and of surgical importance are :

(i) Tracheal Stenosis : (a) Post intubation.
(b) Post tracheostomy
(c) Granulomatous and infections causes.
(d) Congential.

(ii) Tracheal tumours : (a) Squamous epithelial tumours.
(b) Adenocarcinoma
(c) Large cell undifferentiated CA.
(d) Neuroendocrine tumours.
(e) Others

(iii) Thyroid malignancies infiltrating into trachea.

(iv) Tracheo innominate artery fistula.

(v) Tracheo-oesophageal fistula.

PRE OPERATIVE IMAGING:

1. X-ray Neck :-

The AP view provides a good assessment of the airway from the hyoid bone to the carina and main bronchi. The lateral view also provides useful information about the larynx and intra-laryngeal structures as well as posterior pharyngeal wall and pre-cervical tissues.

In addition, fluoroscopy can give information about the tracheal compliance during the Valsalva maneuvers.

(2) Barium studies:- Can evaluate the presence of a tracheo – oesophageal fistula.

(3) CT Scan :

Both 2D Helical CT as well as 3D Reconstructed CT can demonstrate the level of the lesions and their extent accurately. They also give an idea about the adjacent structures in the neck and mediastinum.

(4) Endoscopy :

Flexible bronchoscopy is done preoperatively after imaging studies to study the lesion and its proximal extent inorder to plan for surgical management.

Rigid bronchoscopy aids in tracheal dilation done on the table under GA, prior to surgery to facilitate ventilation during the procedure.

Virtual bronchoscopy using 3 D reconstruction with helical CT has not been able to replace conventional bronchoscopies, due to their less refinement and precision. However it is very useful in locating double strictures.

Oesophagoscopy is done in cases of infiltrating tumours, tracheo-oesophageal fistulae and in concomitant oesophageal strictures.

ANAESTHESIA IN TRACHEAL SURGERY:

Anaesthetic techniques are variable and have advances to a great extent over the past few

decades to enable tracheal surgery to be less trouble some. The major goal is to have an adequate airway.

The salient anaesthetic principles followed in tracheal surgery are :

(1) IV or Inhalational induction.
(2) Spontaneous ventilation initially in patients with dynamic component of obstruction.
(3) Controlled ventilation and single lung ventilation where possible or indicated.
(4) Ventilation during tracheal dilation.
(5) Distal ventilation during resection of lesion.
(6) Railroading technique to provide distal ventilation during reconstruction.
(7) Haemodynamics, fluid and pain management.

Goal at the end of the procedure is to have an extubated patient with an adequate airway Tracheal dilation for treatment of urgent obstruction due to severe stenosis or a tumour can be done prior to definitive resection using Jackson's bronchoscopes.

Femoro-femoral cardio pulmonary bypass can be used in highly unstable patients or those with extensive carinal lesions.

SURGICAL ASPECTS

COMMON APPROACHES:-

(i) Cervical – most cases
(ii)Cervico mediastinal- lower lesions.
(iii)Thoracotomy – carinal and bronchial lesion depending on the level of the lesion and the experience of the surgeons.

MOBILISATION AND RESECTION:

The site of lesion is identified and gentle dissection is carried out. Circumferential dissection is better limited to not more than 1 or 2cm away from the lesion for fear of leading to significant devascularisation. The tumour or the stenotic segment is resected and distal ventilation is established. Anterior and posterior dissection, especially of the distal segment can be safely accomplished using the finger up to the carina. Additional maneuvers which aid in better mobilization are :

(i) Neck flexion.
(ii) Laryngeal release.
(iii) Hilar dissection.
(iv) Inferior pulmonary ligament release

Adjacent structures have to be identified and secured to prevent unwanted complications. The anastomosis of the tracheal ends is done with interrupted 2'0 vicryl sutures after good mobilization and without anastomotic tension.

POST OP MANAGEMENT:

The postop management generally involves the following measures:-

(1) Extubation and maintenance of O2 Saturation.
(2) Flexible bronchoscopy to assess the anastomotic site and to check for residual stenosis or malacia.

(3) Posture of neck flexion to be maintained to prevent anastomotic disruption.
(4) Chest X ray.
(5) Chest physiotherapy regularly.
(6) Oral feeds to be resumed the same day.
(7) Early ambulation.

POST OP COMPLICATIONS:
Tracheal surgery is associated with many complications, most of them preventable and few of them fatal. These are :

(A) **Due to faculty technique**
(1) Grannulation tissue formation.
(2) Anastomotic separation.
(3) Air leakage without major separation.
(4) Anastomotic stenosis.
(5) Tracheal necrosis.
(6) TIA fistula
(7) TE fistula
(8) Vocal cord dysfunction and aspiration.

(B) **Due to failure of Preop diagnosis** :
(1) Glottic Incompetence.
(2) Tracheomalacia.
(3) Actual extent of lesion and multiple stenoses.

(b) **Other complications** – Rare :
(1) Wound infection.
(2) Laryngeal edema.
(3) Post operative pneumonia.
(4) Quadriplegia due to acute neck flexion.

T – TUBES:

T-tubes were developed by William Montgomery in 1965. The major indications for T tube insertion are :

(a) Temporary stenting of the airway prior to definitive resection and to allow inflammation to subside.

(b) Definitive airway in cases where reconstruction is not possible due to insufficient trachea or irresectable tumour.

(c) Airway following failure of tracheal reconstruction either as a temporary or as a permanent measure. The tubes are of various lengths and are made of silicone. The tubes are inserted through the tracheostomy either directly or with bronchoscopic aid. Care of the T-tubes is mandatory.

SPECIAL SITUATIONS :

(a) Tracheo-oesophageal fistula:

TE fistulae can be benign due to inflammatory, infectious traumatic or granulomatous causes usually extending from trachea to the oesophagus or malignant, usually extending from the oesophagus to the trachea.
Benign TE fistulae are usually amenable to surgical repair. The principles of such a repair

includes,

(1) Complete dissection of the fistula.
(2) Division of the fistula.
(3) Tension free repair of the trachea, either primary closure or most often resection and anastomosis.
(4) Primary closure of the oesophageal rent in most cases.

Malignant TE fistulae are usually best treated by palliative care rather than any major reconstruction, considering the limited expectation of life.

(B) **Tracheo-Innominate Artery fistula** :

TIA fistula most often results from
(1) Erosion by the tracheostomy tube.
(2) Erosion by the tracheostomy tube cuff or tip.
(3) Post reconstruction

Less commonly, the fistula results due to trauma or post mediastinal exenteration.

Premonitory minor bleeds may occur, but bleeding is often massive at the outset. Urgent control of major bleeds can be accomplished either by digital control in cases due to erosion by the tube and by endotracheal tube cuff inflation in cases due to erosion by the tube cuff or tip and in post reconstruction cases.

Exploration and definitive surgical reconstruction has to carried out subsequently on an emergency basis. The cervico mediastinal approach has to employed. The artery is best excised and ends oversewn with monofilament sutures. It is essential that arterial reconstruction from the ascending aorta to the right internal carotid artery is carried out. The tracheal reconstruction can be performed at the same sitting if indicated.

Prevention of TIA fistula after tracheal resection and reconstruction:

(1) Avoid dissecting the innominate artery if possible.

(2) Interposition of soft tissues, usually the strap muscles between the anastomosis and the artery if the innominate artery needs to be mobilized.

CONCLUSION :

Tracheal surgery is a technically demanding subspecialty of cardio thoracic surgery which also requires meticulous preop planning, good anaesthetic surveillance, careful post operative care and encountering potentially fatal condition on occasions.
Prevention of post intubation stenosis with large volume low pressure cuffs has to be the key to bring down the incidence of benign cases. Adjuvant and palliative treatment have to be improved in patient with malignant lesions. Overall, tracheal surgery, when done with commitment and attention to all facts yields gratifying results.

REFERENCES:

Grillo HC. In : Surgery of the trachea and bronchi : Grillo HC 1st edn. London:BC Decker Inc; 2004

Grillo HC, Donaque MD, Mathisen DJ, Wain JC, Wright CD. Post intubation tracheal stenosis. J Thorac Cardiovasc Surg 1995:109(3): 486-93.

Allan JS, Wright CD, Tracheo innominate fistula: Diagnosis and management. Chest Surg Clin N Am 2003;13:331-41.

Donahue DM, Grillo HC, Wain JC, Wright CD< Mathisen DJ, Reoperative tracheal resection and reconstruction for unsuccessful repair of post intubation

stenosis. J Thorac Cardio Vasc Surg: 114(6):934-9.

BENIGN OESOPHAGEAL DISEASE – Indian Prospective

Professor S. Chandramohan – Madras, India.

The commonest benign oesophageal disorder encountered is corrosive injury to the oesophagus. As ours is a tertiary referral centre, majority of them are referred at the stage of "Stricture" or failed therapy – surgical or non-surgical.

Acute corrosive injuries are essentially managed conservatively except situations where there is peritonitis or mediastinitis due to transmural injury and perforation. Careful endoscopy is performed to assess the extent of damage. Nasogastric tube is passed only if there is no suspicion of transmural damage. Steroids are reserved for acute respiratory symptoms due to oedema. Endotracheal intubation and tracheostomy are reserved for extreme situations.

Once acute stage is over, patients go into dilatation protocol if they have isolated, short segment stricture. In patients with long segment strictures, multiple strictures, stricture involving multiple organs, failed or complication of dilatation – surgery is preferred.

Major problems encountered are due to:

Difficulty in distal assessment
Extent of involvement
Choosing the appropriate conduit
Preserving the functions of speaking and swallowing in patients in complex pharyngeal strictures.
Preventing the feared complication of leak and anastomotic stricture.

Over the last ten years, we have made lot of modifications in the management of corrosive pharyngo-oesophageal strictures in an attempt to reduce morbidity, mortality and improving QOL.

Issues in the management:

Isolated oesophageal strictures are managed using gastric tube. Combined oesophagogastric strictures require a coloplasty. In patients with total obstruction precluding distal assessment preoperatively, neck is explored first and intra-operative endoscopy is performed before reconstruction.

No attempt is made to resect the oesophagus in diffuse long segment strictures who has undergone multiple dilatations and in patients who has had perforation, as there will be extensive perioesophagitis.

In patients requiring long length of conduit, we use our modified technique of gastric tubularisation, where 5-7cm extra length is gained and GE junction becomes the upper most point for anastomosis.

We always perform isoperistaltic coloplasty. The major problems of ischemia, leak, conduit necrosis and redundant colon at cologastric anastomosis is overcome by our modified technique.

The colonic conduit is based on the left colic artery, preserving both ascending and descending branches (charged Colon) and the middle colic artery is also preserved where possible (supercharged colon). The arterial arcade is also preserved. Distal colon transection is done as high as possible to avoid redundancy.

In pharyngeal strictures, laryngopharyngectomy and tracheostomy are avoided where possible. Anastomosis is done to the posterior pharyngeal wall when available or to one of the pyriform fossa.
The outcome after pharyngeal anastomosis has improved after we started transanastomotic

stenting with 7.5 –8.5 size cuffed endotracheal tube kept for a period of two weeks.

Postoperative anastomotic stenosis is initially managed by us with dilatations and later on by self dilatation by patients using a Foley's catheter technique.

Conduit necrosis is managed with alternative organs depending upon the availability.

Dysphagia due to tuberculosis is another important benign disease encountered. It could be due to luminal disease or nodal disease – usually due to mediastinal nodal suppuration. Treatment is essentially medical and surgery is reserved for complications or failed medical therapy.

Less common benign diseases warranting intervention include:

- Benign tumours – Leiomyoma
- Achalasia Cardia
- Reflux and hiatus hernia
- Foreign bodies
- Oesophageal Perforations

REFERENCES:

Management of corrosive esophageal burns in 149 cases. Zhou JH et al. J Thorac Cardiovasc Surg. 2005 Aug;130(2):449-55.

Pharyngooesophagogastric Corrosive Strictures - Dilemmas in management: To eat or to speak? Experience with 35 patients SM Chandramohan M Kanagavel S Rathinam A66, Vol 17 Supplement 1 2004 Diseases of the Oesophagus.

Corrosive injuries to the Upper Gastrointestinal Tract – Strategies for a better Outcome S M Chandramohan, MKanagavel, S Rathinam S9 The Surgeon supplement June2005 Vol 3 No 3

Conduit Necrosis in Oesophageal Surgery – Management Strategy S M Chandramohan M Kanagavel, S Rathinam S65. The Surgeon supplement June 2005 Vol 3 No 3

Esophageal leiomyoma: a 40-year experience. Mutrie CJ et al.Ann Thorac Surg. 2005 Apr;79(4):1122-5.

Imaging of esophageal tuberculosis: a review of 23 cases. Nagi et al. Acta Radiol. 2003 May;44(3):329-33.

Esophageal tuberculosis associated with esophagotracheal or esophagomediastinal fistula: report of 10 cases. Devarbhavi HC et al. Gastrointest Endosc. 2003 Apr;57(4):588-92.

Dysphagia due to Tuberculosis SM Chandramohan M Kanagavel S Rathinam Rajan Santhosam B S Tiruvadanan A48 Vol 17 Supplement 1 2004 Diseases of the Oesophagus.

Surgical treatment of giant esophageal leiomyoma. Cheng BC et al. World J Gastroenterol. 2005 Jul 21;11(27):4258-60.

MALIGNANT DISEASE OF THE OESOPHAGUS – The Indian Prospective

Professor R. Santosham – Chennai, India.

Carcinoma Oesophagus has been one of the most frequent indications for Oesophageal surgery all over the world. Surgery of the oesophagus was primarily dealt by Thoracic surgeons few decades ago and later on it was taken over by Surgical Gastroenterologists. However world over, still good numbers of thoracic surgeons have primary interest in oesophageal surgery.

EPIDEMIOLOGY IN INDIA

According to the Madras Metropolitan Tumour Registry **(MMTR),**

(i) CA oesophagus is the 3rd most common malignancy in men and 5th most common malignancy in women, among all cancers.
(ii) Increased incidence is predominantly due to the use of tobacco and alcohol. In women, increased incidence is observed in the Muslim population possibly due to the use of snuff and cigars.
(iii) Affected men are usually in their sixth decade.
(iv) The most common tumour status is T3 and the nodal status is variable, though majority of them have involvement of more than two fields.

ASSESSMENT:

Since screening for CA oesophagus is not practised in India, the patients present with the usual symptoms of dysphagia, odynophagia and constitutional symptoms. The work up of these patients involves.

(1) **Upper GI Endoscopy** :

Through it is a good diagnostic tool which ensures a tissue diagnosis it is difficult to assess the distal extent of the tumour with this modality, especially in stenotic lesions.

(2) **Barium Swallow** :

The extent of the tumour can be mapped with this standard investigation which has stood the test of time.

(3) **CT Scan** :

It is of great importance in assessing the involvement of adjacent vital structures like the aorta, carina , lower part of trachea and the left atrium. A wide based involvement of the aorta precludes resection of any kind. It can also assess mode enlargement but cannot prove them to be histologically malignant.

(4) **Endoscopic Ultrasound**:

Endoscopic ultrasound has been shown to be around 90% sensitive in assessing the

accurate depth of tumour invasion. However this modality may not be possible to be carried out in the presence of a complete malignant stricture. Since this is relatively new technology which is limited to a few centres, observer dependent errors and learning curves have their own impacts on this. When it is combined with Contrast enhanced CT scan, the yield increases mariginally.

(5) **Fiberoptic Bronchoscopy** :

Tumours of the middle third of the oesophagus and these which lie in proximity to the carina require bronchoscopy to evaluate whether the tracheo- bronchial tree is infiltrated or not.

PREOP PREPARATION- SALIENT FEATURES

(i) Cardiac evaluation (Echo, Stress ECG) since most of the patients are elderly and or have associated heart disease.

(ii) Pulmonary function tests, as majority of them are smokers.

(iii) Cessation of smoking.

(iv) Breathing exercises using Incentive spirometer.

(v) Aspiration pneumonia to be critically assessed and treated using CT Scan as an adjunct tool.

TREATMENT OPTIONS:

(A) **Adjuvant Radiotherapy and Induction chemotherapy**:

The advantages are that the tumour is downstaged to a considerable extent and there appears to be improved 5 year survival rates with this approach.
In our country, the main disadvantage with this protocol seems to be the failure of patients to follow up once their symptoms are alleviated.

(B) SURGERY:

We operate on malignant oesophageal lesions from subcarinal level to the GE junction when the tracheo-bronchial tree or aorta are not involved. The common principles that we have to focus on are

(1) **Route & access** : -

Certain routes are specific like the transhiatal route for CA of the lower third of the oesophagus. T.H.E has lesser incidence of pulmonary complications. In any case, the morbidity is less when a thoracotomy is avoided. Interestingly most of the thoracic surgeons like to do a thoracotomy the rule out carinal and tracheal infiltration in middle third growths.

(2) Extent of resection :-

John Wong and Simon Law at al have clearly established that a clearance of 10cm prevents anastomotic site recurrence to a significant extent. The transhiatal procedure satisfies the above criteria much better than the other techniques.

(3) **Nodal assessment and dissection** :-

In patients with T3 disease, more than two thirds of them have involvement of at least 2 to 3 nodal regions, and majority of them have > 5 positive nodes.
Aggressive 3 stage nodal dissection is not practised because, the out come is not any different if 3 or more nodes are involved. The major complications of 3 stage nodal dissection are:

(i) Pulmonary : Right main bronchial stenosis.
Recurrent laryngeal nerve involvement -present in upto 75% cases and associated with a higher morbidity. (Fujita et al 1995.)

(ii) Cardiac Arrythmias.

(4) **Choice of conduit** :

The stomach is the most commonly preferred neo-oesphagus due to its good vascularity. Also it can be easily brought up to the hypopharynx and needs only a single anastomosis. Partial stapling and hand sewn anastomosis of the remaining wall offers best results. However the stomach has a few disadvantages like the risks of reflux, aspiration and stricture formation.

The colon is used primarily as a neo-oesophagus in benign strictures, but is also used in carcinoma when the stomach is not available. But it is technically demanding and requires multiple anastomoses to be performed.

(5) **En bloc resection of Oesphagus, Pleura and Thoracic duct** :

Such more radically resections do not offer any better survival in a country where most of the patients are picked up at a later stage of the disease.
Moreover these resections are definitely associated with more morbidity, longer ICU stay and prolonged mechanical ventilation.

ANASTOMOTIC LEAKS AND THEIR MANAGEMENT:-

Leaks have been the bane of oesophageal surgery and success lies in their prevention and management.

ETIOLOGICAL FACTORS :-
Factors which make an oesophageal anastomosis more prone for leakage are:

(a) Anatomical and physiological factors:

(1) Absence of oesphageal serosal layers.
(2) Fragile wall, mainly longitudinal muscle layer.
(3) Marginally adequate blood supply.
(4) Negative intra thoracic pressure.
(5) Presence of digestive enzymes or acidic environment.

(b) Perioperative factors :

(1) Hypo albuminema and malnutrition.
(2) Female sex
(3) Excess intraoperative blood loss
(4) Delayed gastric emptying
(5) Obesity
(6) Increased duration of surgery.

(c **) Technical factors :**

(1) Sutured Vs stapled technique.
(2) Continuous Vs Interrupted sutures.
(3) Two layers Vs single layer.
(4) Use of colon Vs stomach as conduit.
(5) Retrosternal Vs Posterior mediastinal route.
(6) Cervical Vs Intra thoracic anastomosis.

Most of the leaks can be avoided by weighing these factors for each individual.

MANAGEMENT OF LEAKS:

(1) Most of the leaks are **contained** and heal spontaneously with conservative management, more so in cases where the anastomosis is placed in the neck.

(2) **Uncontained** leaks, which usually are intra thoracic may lead to.

(i) External Fistulae.
(ii) Invasion of adjacent structures – airway or major vessels.
(iii) Septicaemia, increased morbidity and mortality.

These leaks have to be assessed and as per the need, have to undergo reconstruction, exclusion or bypass.

(3) **Feeding Jejunostomy** is performed in most of the cases as a route of enteral nutrition.

CONCLUSION:-

Surgery in malignant disease of the oesophagus can offer setbacks to any surgeon due to the poor survival rates, aggressive nature of the tumours, late presentation of patients, post op complications like anastomotic leaks which may be devastating at times. However, all said and done, strict adherence to the principles of patient selection, resection with good clearance, appropriate conduit placement, prevention and management of anastomotic leaks and adjuvant treatment when indicated, leads to satisfactory results in a significant number of patients.

REFERENCES:

Franco K L, Putnam J B, In : Advanced therapy in Thoracic surgery.1998 London, BC Decker Inc.; 431-440, 455-471

Grifffin S M, Woods S D S, Chan A, et al. Early and late surgical complications of Subtotal oesophagectomy for Squamous carcinoma of oesophagus. J R Coll Surg Edin 1991 ; 36 : 170-173

Tstsui S, Moriguchi S, Morita M, et al. Multivariate analysis of postoperative complications after oesophageal resection. Ann Thorac surg 1992; 53: 1052-6

Goldminc M, Maddern G et al. Br J Surg 1993; 80 : 367-370
Wong J, Am J Surg 1997; 174: 320-324
Urschel J D, Am J Surg 1995; 169: 634-640
Swanson S J. Minerva Chir 2002; 57: 795-810
Baba M, Natsugoe S, Shimada M. J Am Coll Surg 1999; 188: 231-236
Hulscher J B F et al. N Engl J Med 2002; 347: 1662-1669
Van Sandick et al. J Am Coll Surg 2002; 194: 28-36

SURGICAL MANAGEMENT OF BENIGN OESOPHAGEAL DISEASE – A UK PERSPECTIVE

Mr. J. Duffy - Nottingham City Hospital.

Overview

Gastrooesophageal reflux disease.

- Indications for surgery
- Surgical options – Transthoracic (Belsey MkIV, anchored Nissen, Gastroplasty)
  - Transabdominal (Nissen fundoplication)
  - Laparoscopic fundoplication (Nissen,Toupet; Dor)
- New approaches – endoscopic

- Paraoesophageal hernia
- Definition
- Indications for surgery
- Surgical approach – thoracotomy
  - laparotomy
  - laparoscopy

Barretts oesophagus

- Definition
- Indications for surgery

Oesophageal strictures

- Aetiology
- Surgical management – dilatation + PPIs
  - dilatation + antireflux surgery / gastroplasty
  - oesophageal resection

Motility disorders

- Indications for treatment
- Treatment options – drugs
  - dilatation
  - myotomy (minimally invasive or open)
  - resection

Oesophageal diverticula

- Pulsion diverticula – pharyngeal pouch
  - epiphrenic diverticulum
- Traction diverticula – midoesophageal diverticulum
- Treatment – treat motility disorder (myotomy)
  - excise diverticulum

Miscellaneous conditions

Benign tumours

Cysts

Management of foreign bodies in the oesophagus

Principles of treatment of oesophageal perforation

SURGICAL TREATMENT OF OESOPHAGEAL CARCINOMA –

The UK Perspective

Mr. R. Page - The Cardiothoracic Centre, Liverpool.

Aims of Surgery

1. Long term disease remission (after surgery 5-year survival = 20%, i.e. poor)
2. Long term palliation of dysphagia (by providing loco-regional control of disease)

Prognosis after resection

Determined by:-

1. Presence of nodal metastases, especially "regional" (vs. "local")
2. Completeness of resection (R0, R1, R2)
3. Performance status of patient

Problems with tumour staging and patient selection

CT +/- PET scanning good for distant metastases (M status), poor for local staging (T + N status)

Endo-oesophageal U/S not widely available, but accuracy is good in experienced operators. Biopsy of nodes becoming more routine (as for mediastinoscopy in lung cancer)

All local staging methods *inaccurate after* chemotherapy or radiotherapy

High morbidity from surgery; quality of life poorer for up to 12 months compared to pre-op status

Pre-operative risk stratification relatively crude

Multi-modality therapy (Surgery ± Chemotherapy ± DXT)

? Evidence for long-term survival of different combinations:-

1. Surgery versus DXT — Surgery better (small, randomised trials)

2. Pre-op DXT versus Surgery alone — No advantage (even with meta-analysis)

3. Pre-op Chemotherapy versus Surgery alone ("neoadjuvant" therapy)
   a) MRC OEO2 Trial (UK), 2002
      802 patients, 2 pre-op cycles of cisplatin + 5-FU over 6 weeks
      10% survival advantage at 2 years
      Currently is standard of care in UK for eligible patients
   b) Intergroup American Trial, 1998
      467 patients, 3 pre-op + 2 post-op cycles of cisplatin + 5-FU
      Fewer patients underwent resection (compared with OEO2 trial)
      No survival advantage. Toxicity and compliance a major problem

4. Pre-op Chemo+DXT >> surgery, versus surgery alone
   "Chemo-sensitisation" effect of chemotherapy on subsequent radiotherapy
   Six randomised trials, all showing trend to better survival, compared to surgery alone
   Therapy extends over many months. High treatment morbidity + mortality even in the best units. Not appropriate for many patients

5. Chemo+DXT alone (i.e. no resection)
   Complete responders may achieve similar long-term survival to surgery alone, especially for squamous carcinoma. Local failure higher without surgery (Stahl, 2005).

Complete (cPR) versus partial (pPR) responders

Only logical to avoid surgery in those with a complete pathological response (cPR), but this is difficult to ascertain without surgery!

Until Chemo+DXT can achieve consistently high rates of locoregional control, surgery should remain an integral part of the multi-modality treatment of oesophageal cancer.

References

1. Geh JI, Crellin AM, Glynne-Jones R
Preoperative (neoadjuvant) chemoradiotherapy in oesophageal cancer Br J Surg, 2001;88:338-356
2. Medical Research Council Oesophageal Cancer Working Party
Surgical resection with and without preoperative chemotherapy in oesophageal cancer: a randomised controlled trial Lancet, 2002;359:1727-1733
3. Kelsen DP, Ginsberg R, Pajak TF et al
Chemotherapy followed by surgery compared with surgery alone for localized esophageal cancer N Eng J Med, 1998;339:1979-1984
4. Stahl M et al
Chemoradiation with and without surgery in patients with locally advanced squamous carcinoma of the esophagus J Clin Oncol, 2005;23:2310-2317

ADVANCES IN CARDIOTHORACIC IMAGING

Dr. G. McGann - Gloucestershire Hospitals NHS Foundation Trust.

Plain radiography of the chest still forms the mainstay of chest imaging. However, the newer, dynamic techniques of multidetector CT and chest MRI can be used to consolidate expertise in plain radiography, elaborate on abnormal findings and occasionally show findings invisible on chest x-ray. CT has undergone a recent renaissance with the advent of multidetector imaging, providing ultra-fast, high definition imaging even in the profoundly ill or uncooperative patient.

Marked recent improvement has occurred in the imaging of the thoracic inlet, vascular diseases of the chest and coronary artery imaging. This talk will explore new opportunities in chest imaging and discuss methods of replacing invasive with non-invasive techniques for complex diagnosis. The application of diagnostic techniques to guide surgical and radiological interventions is explored.

References:

1. 'Essentials of Thoracic Imaging', ed. Caroline Chiles. *Radiologic Clinics of North America*. 43.3 (May 2005).
2. 'Cardiac Imaging'. *Seminars in Roentgenology.* 38.4. (October 2003).
3. 'Lung Cancer'. *Seminars in Roentgenology.* 40.2. (April 2005).
4. 'Recent Advances in Non-Invasive Cardiology'. *BMJ.* Vol 330 (March 2005), page 731.
5. 'Imaging Liver Metastases; Current Limitations and Future Prospects'. *Robinson British Journal of Radiology.* 73 (pp. 234-241). 2000.
6. Differentiation of Benign and Malignant Lesions. *Radiographics 20:43 – 58. 2000. Erasmus JJ et al.*
7. Invasive Staging of NSCLC. *Toloza EM et al. Chest. 123.157S – 166S. 2003.*