CIBTech Journal of Surgery ISSN: 2319-3875 (Online)
An Online International Journal Available at http://www.cibtech.org/cjs.htm
2013 Vol. 2 (3) September-December, pp.37-51/Abid et al.
Research Article

A STUDY ON OUTCOME OF VARIOUS SURGICAL MODALITIES FOR LOWER THIRD ESOPHAGEAL CANCER A SINGLE CENTER EXPERIENCE

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ABSTRACT
The objective behind the correct study was to determine the outcome of various surgical modalities in patients with lower third esophageal cancer in terms of: Operative time. Intra -operative complications. Conversion rates, post operative morbidity, Mortality. Our study included 35 Patients, endoscopy and biopsy proven cases of lower third oesophageal carcinoma. On admission a detailed history and examination was done. Appropriate laboratory and radiological work up was done. Patients were subjected different approachs: Transabdominal approach (TA). Ivor-Lewis (IL) technique, transhiatal (TH) approach. There were no significant differences noted among the various surgical modalities employed, in terms of morbidity and mortality. Although Ivor Lewis technique is associated with significantly increased operative time, operative blood loss and hospital stay, this does not however translate into increased mortality. Because of a small sample size and limited follow up, our data does not permit us to make a clear recommendation of one surgical modality over the other.

Key Words: *Oesophageal Carcinoma, Transthoracic, Transabdominal*

INTRODUCTION
Currently the technological advances in instruments and treatment options available are amazing when compared with even 50 years ago, but the majority of cases are still diagnosed at late stage and there has been no substantial overall improvement in outcomes from this insidious disease Eslick (2009). Czerny in the year 1877, was the first to successfully resects the cervical esophagus for carcinoma in human beings. Torek, using a transthoracic approach, was the first to successfully resect an esophageal carcinoma in 1913. It was Ivor Lewis in 1946 who introduced esophagectomy and esophagogastrostomy through a right thoractomy. Later the technique was revived of Gray Turner's "esophagectomy without thoracotomy" in the year Lee and Miller (1997). *Dysphagia* is a usual presenting feature and is generally a sign of advanced disease. *Weight loss, hoarseness* due to recurrent laryngeal nerve palsy and *palpable lymphadenopathy* in the neck are signs of advanced disease. Patients with early disease may present with either non specific dyspeptic symptoms or a vague feeling while swallowing. Locoregional spread occurs through the wall of esophagus into the adjacent structures, along the wall of esophagus in the sub mucosal lymphatics and to regional lymph nodes. Distant regional lymph nodes may be invaded even when local nodes are free of tumor and there may be satellite nodules in the esophagus proximal to the main tumour. Spread to the celiac axis nodes from a lesion in the intra thoracic esophagus is a bad prognostic sign and is regarded as metastasis (M) rather than nodal (N) disease in the TNM classification. Systemic spread is mainly to the liver and lungs, but practically any organ can be involved including brain, bone and skin[3]. The *curative treatment* involves radical surgery or radiotherapy. Surgical resection gives the best results for all forms of esophageal cancer. Radiotherapy can cure both squamous cell and adenocarcinoma, but poses technical problems at the lower end of esophagus. Tumors that involve the stomach (cardia) are not generally accepted for radiotherapy. The results of radiotherapy have been improved by concurrent

chemotherapy, so- called chemo- radiotherapy (Law and Wong, 2007; Zwischenberger *et al.*, 2004; Blot and Fraumeni, 1987; Peters and De-Meester, 2005).

Curative surgery involves resection of an appropriate length of the esophagus with generous proximal clearance together with any involved stomach and the locoregional lymphatics. Restoration of continuity is almost always achieved by transposition of the stomach and the esophagogastric anastomosis. Colon or, less commonly small intestine may be interposed between the stomach and the esophageal remnant, but is a more major undertaking with a higher postoperative mortality. For subtotal esophagectomy, a variety of approaches are possible. The most commonly used is the *Ivor Lewis approach* which opens the abdomen and thoracic cavities in two stages. The original procedure as described by Ivor Lewis in 1946 to treat squamous cell carcinoma of the midesophagus was a two-stage approach including an abdominal incision to mobilize the gastric conduit followed, after an interval of 1 to 2 weeks, by a right thoracotomy for resection and reconstruction of the esophagus. Currently, the transthoracic esophagectomy is performed as a combined procedure requiring only one general anaesthetic administration. This remains a favoured approach for midesophageal malignancies and is used commonly for distal esophageal carcinomas. *Transhiatal esophagectomy* approach has been popularized by Orringer in USA and Pinotti in Brazil. The surgical procedure as performed routinely consists of an upper midline abdominal incision and left cervical incision.

In the *McKeown operation*, a third incision in the neck is made to complete the cervical anastomosis (Law and Wong, 2007; Zwischenberger *et al.*, 2004; Blot and Fraumeni, 1987; Peters and De-Meester, 2005). A *left thoracoabdominal incision* through the seventh or eighth rib space also gives excellent exposure of the low mediastinum and upper abdomen. A single *left thoracotomy* with opening up of the diaphragm is also an option. This gives reasonable exposure to the upper abdomen as well. However, lymphadenectomy towards the hepatoduodenal ligament is hampered. When a thoracotomy is not desired, opening the hiatus widely by splitting the crura laterally and the diaphragm anteriorly can gain access to the low posterior mediastinum, and distal esophagectomy can be performed with the anastomosis performed from the abdomen without the need for a thoracic incision. The anastomosis is made easier with a mechanical stapler. When the proximal stomach is involved by tumor, a total gastrectomy with Roux-en-Y reconstruction is preferred by many (Law and Wong, 2007).

MATERIALS AND METHODS

This study was a prospective study and included patients admitted for elective surgery for lower third oesophageal cancer in various surgical wards of Department of Surgery, Government Medical College Srinagar, between June 2010 and June 2013. Our study included 35 Patients, endoscopy and biopsy proven cases of lower third oesophageal carcinoma. On admission a detailed history and examination was done. Appropriate laboratory and radiological work up was done including complete hemogram, coagulogram including INR, PT, APTT, blood grouping, LFT, blood sugar, KFT, serum electrolytes, ECG, chest x-ray, USG abdomen and pelvis and CT chest and abdomen. Pulmonary function tests were performed in patients with respiratory co morbidities viz COPD, Restrictive lung diseases. Exclusion criteria included: Metastatic disease at the outset. Laparotomy findings of inoperability and unresectibility of growth wherein only feeding jejunostomy was performed. Surgical procedures were performed by senior consultants of all units in the elective operation theatres of the Department of surgery, GMC Srinagar. All the patients were subjected to undergo a formal preanaesthetic check up. Written and Informed consent was taken from the patient/ attendants (of the patient) in their own language.

Transabdominal Approach (TA)

Patients with growths limited to the abdominal esophagus on endoscopy and without mediastinal lymphadenopathy (on CT) were subjected to undergo the transabdominal approach.

All the patients were opened by a midline upper abdominal incision from xiphoid process to the umbilicus. The resectibility and operability of the tumour was assessed and only feeding jejunostomy was performed if the growth was unresectable or the patient inoperable.

If adequate length of the esophagus proximal to the tumour (at least 5 cm) was achieved, then satinsky clamp was applied and esophagus divided taking at least a 5 cm tumour free proximal margin. The specimen was divided distally over intestinal clamps taking appropriate distal margins. The esophagogastric anastomosis was performed with a double layer of full-thickness interrupted sutures. Ryle's tube was fixed after positioning it below the suture line. Drains were placed and secured. A feeding jejunostomy was routinely performed. The abdomen was closed back in layers.

If the growth involved the distal esophagus and proximal portion of the stomach, then distal esophagectomy with total gastrectomy was contemplated and Roux en Y end to side esophagojejunostomy with end to side enteroenterostomy performed. A feeding jejunostomy was routinely performed distal to the enteroenterostomy.

However if anastomosis by abdominal approach was expected to be under tension or there was high extension of tumor and mediastinal lymphadenopathy on CT, then the patients were subjected to a right thoracotomy also and Ivor Lewis procedure performed in those cases.

Ivor-Lewis (IL) Technique

The abdominal part of the procedure was performed as discussed above, upto the mobilisation of the stomach and Gastroesophageal junction. After doing a feeding jejunostomy and putting and securing the abdominal drains, the abdominal wound was closed and dressed and the patient was placed in the left lateral decubitus position. A right posterolateral thoracotomy was performed, and the chest was entered through the fourth or fifth interspace.

The azygos vein was divided and the intrathoracic esophagus dissected. All lymphatic tissue was included with the esophagus. The mobilized stomach tube was pulled up into the chest. Adequate resection margins were achieved on either side of the growth and resection performed. A hand sewn end to side esophagogastrostomy was performed in two layers. The nasogastric tube was passed after completion of the posterior wall. The anastomosis was usually performed high in the chest at or above the level of the azygos vein. The anastomosis was constructed using a hand-sewn technique. A 28F straight chest tube was placed into the apex of the chest via a separate stab incision. The chest was closed in 4 layers and appropriately dressed.

In patients with a lesion limited to the lower esophagus but with respiratory co morbidities a transhiatal resection was contemplated.

Transhiatal (TH) Approach

The patient was placed in the supine position with the head rotated 45 degrees to the right. The abdominal phase of the operation was performed in identical fashion as described above. The phrenoesophageal ligament was divided and the lower esophagus encircled with a 1" wide Penrose drain. The hiatus was dilated to allow entry of the surgeon's hand. Arterial branches from the aorta were clipped on the aortic side and divided.

A incision was made in the left neck along the anterior border of the sternocleidomastoid muscle starting at the sternal notch and extending 6-8 cm. The platysma was divided. The sternocleidomastoid muscle and carotid sheath were retracted laterally. The omohyoid and middle thyroid vein were divided. The esophagus was palpated anterior to the spine and posterior to the trachea. Sharp dissection was carried out immediately on the esophagus, separating the esophagus from the membranous trachea and recurrent nerve. The esophagus was looped with a 1" Penrose drain. Blunt dissection of the posterior plane of the esophagus was performed.

From the abdomen, the surgeon placed his hand in between the spine and esophagus with the palmar aspect immediately against the esophagus. This was performed in conjunction with raising the esophagus anteriorly with the aid of the Penrose drain. An identical manoeuvre was performed through the cervical incision. When sufficient dissection was done from either side, both hands were introduced

simultaneously and an attempt was made to touch fingertips. Dissection was carried over the anterior esophagus in nearly identical fashion. A gentle side-to-side motion of the fingertips was used to separate the trachea from esophagus. Eventually the fingertips from both hands were united. Once the anterior and posterior dissection was completed, the lateral attachments were divided. The esophagus proximal to the growth was divided via the cervical incision. A 2^0 silk suture was attached to the proximal margin and the specimen was drawn out into the abdomen. The cervical end of this tie was fastened to a clamp. The gastric tube was then constructed by respecting adequate distal margin. The specimen was removed. The esophageal hiatus was dilated to admit four fingers.

The conduit was advanced into the neck incision, ensuring appropriate orientation. The neck anastomosis was hand sewn using interrupted full-thickness 3-0 silk sutures. A soft drain was routinely placed posterior to the anastomosis and the platysma and skin were closed separately. Before closing the abdomen, a feeding jejunostomy was performed approximately 40 cm distal to the ligament of Treitz. Abdominal drains were placed and secured.

The abdominal wound was sutured in layers and dressed. During the performance of all the above procedures, the below mentioned variables were routinely noted. The *operative time* was noted from making the skin incision (or making of the first incision in case of IL and TH techniques) up to the closure of the last skin incision. For every procedure the *blood loss* was measured with the help of suction apparatus containing graduated containers. The blood clots were separately collected in the kidney trays and measured on a weighing machine.

Packs used were weighed, both before and after usage and these were recorded by the medical intern. Other *Intraoperative complications* were noted and recorded.

Postoperative care of the patients was done in surgical ICU and surgical wards with hourly documentation of the vitals and drainage during the 1^{st} 24 hrs. Postoperative Hb, ABG and electrolytes were sent and disparity, if any with the normal values, corrected accordingly. Histopathological examination of the resected specimen was done in all cases.

In the surgical wards patients were observed for the development of any complication until discharged. The development of *Anastomotic leak* was noted. Anastomotic leakage included both clinical leakage and subclinical leakage (seen only radio logically). Thoracic leaks were heralded by unexplained fever, elevated white cell count, respiratory failure and hypotension. Fever, fluctuance and erythema in the neck incision in case of Transhiatal technique signified a leak.

Respiratory complications were assessed separately for every procedure. These were qualified as pneumonia (i.e infiltrate on the chest x-ray or pathogenic sputum culture for which antibiotics were given), Atelectasis (significant collapse on chest x-ray), pleural effusion and respiratory failure.

The development of *chylothorax* was suspected once the chest tube drainage remained high (>800 ml/24 hrs) and was confirmed by estimation of triglycerides (>1mmol/l) and lymphocyte count (> 90 %) of the fluid. *Postoperative mortality* was qualified as deaths due to a medical or surgical cause within 30 days of the said procedure or within the same hospital admission.

Patients were followed up regularly in the OPD. First, weekly for one month, followed by monthly, patients who complained of dysphagia were subjected to an upper GI endoscopy. If any suspicious lesion was seen, a biopsy was taken and development of *anastomotic recurrence* confirmed.

Jejunostomy feeds with fluids were started once the bowel sounds returned. In patients without any suspicion of anastomotic leakage the Ryles tube was removed on 3^{rd} to 5^{th} day. In all the patients a dye study (conray/methylene blue/charcoal) was undertaken usually on the 7^{th} postoperative day and liquid orals started if no leak was detected.

The tubes were removed upon cessation of significant drainage. During the in hospital stay chest physiotherapy was given and early mobilisation encouraged.

Patients were referred to the department of Medical oncology GMC for adjuvant therapy if indicated.

Patients were followed regularly in the surgical opd's first weekly for 1 month followed by monthly.

Statistical Analysis

Statistical analysis was done by Graphpad instat version 3.10 for windows. Graph pad softwares inc., San Deigo, California USA). To calculate the P values Fisher's exact test or ANOVA was used, as and when needed. A P value of <0.05 was considered significant.

RESULTS AND DISCUSSION

Observations

A total of 35 patients were included in the study our maximum patients belonged to the 6^{th} and 7^{th} decades of life (65.71 %). The youngest patient was 43 years old while the eldest one was 84 years old. There were 26 males and 9 females in our study with a male to female ratio of 2.9: 1.

Table 1: Presentation of patients in our study

Symptoms	No. of Patients	Percentage
Dysphagia	27	77.14
Weight loss	3	8.57
Loss of appetite	3	8.57
Odynophagia	1	2.85
Vomiting	1	2.85
Total	35	100

Dysphagia was the presenting feature in most of the patients (77.14 %) in our study. Rest of the Patients presented with symptoms like weight loss, loss of appetite, vomiting and painful deglutition.

The most common histology encountered in our study was adenocarcinoma (79.98 %) followed by squamous cell carcinoma (17.14 %) as depicted in the table 4.

Table 2: Operative technique

Technique	No. of Patients	%age
Ivor Lewis	8	(22.85)
Transabdominal	22	(62.85)
Transhiatal	5	(14.28)
Total	35	(100.0)

As is shown above in table 2, the most commonly performed procedure in our study was the transabdominal approach (62.85 %).

Table 3: Operative time

Procedure	Mean operative time (minutes)	P value
Ivor Lewis (IL)	350 +/-30.706	IL vs. TA < 0.001
Transabdominal (TA)	200.23 +/-19.669	TA vs. TH<0.001
Transhiatal (TH)	253 +/-12.227	IL vs.TH <0.001

The mean operative time was 350 +/-30.706 min for the Ivor Lewis procedure which was significantly more than the transabdominal as well as the transhiatal techniques. The mean operating times of other procedures are given in table 3.

Table 4: Intraoperative complications

Procedure	Number of patients with Complications					total	% age
	Vessel injury	Pneumothorax	Hypotension	Splenic injury	Thoracic duct injury		
Ivor lewis	1	0	0	0	1	2	25
Transabdominal	0	2	0	2	0	4	18.18
Transhiatal	0	1	1	0	0	2	40
Total	1	3	1	2	1	8	22.85

As can be seen from above table pneumothorax was the most common operative complication followed by splenic injury.

Table 5: Operative blood loss

Procedure	Mean Operative Blood Loss	P Value
Ivor Lewis	1900 +/-292.77 ml	IL vs. TA <0.05
Transabdominal	545 +/-248.29 ml	TAvs.TH <0.05
Transhiatal	1200 +/-209.17 ml	ILvs.TH <0.05

The average blood loss was significantly more for the Ivor Lewis technique and lowest for a trans abdominal approach, signifying the combined role of two incisions and extensive dissection carried out in the IL procedure. Table 5 shows the average blood loss for each procedure.

Table 6: Post operative respiratory complications

Procedure	Pneumonia	Pleural effusion	Basal atelectasis	Total	P Value
Ivor Lewis	1	1	0	2	IL vs. TA,0.1655
Transabdominal	0	0	1	1	TA vs.TH 0.3419
Transhiatal	1	0	0	1	IL vs TH, 1.000
Total	2	1	1	4	

Postoperative pulmonary complications were seen with the highest frequency in the Ivor Lewis group followed by the transhiatal group as depicted in table 6 however the occurance of these complications carried no statistical significance among different modalities.

Table 7: Anastomotic leak

Procedure	Patients with Leak	P value
Ivor Lewis	1	IL vs. TA ,P=1.0000
Transabdominal	2	TA vs. TH,P=0.4735
Transhiatal	1	IL vs. TH, P=1.0000
Total	4	

Table 7 shows that leakage at the anastomotic site occurred in 4 patients in our study including 1 patient each in the Ivor Lewis and Transhiatal group and 2 patients in the Transabdominal group. As can be seen from the above table the leak rates among different groups were not significant.
Wound infection was seen in 5 of our patients. It was seen in 25 % of patients operated by the Ivor Lewis technique.
The wound infection rate among the various surgical modalities was not significant.
One patient each from the Ivor Lewis and Transhiatal groups developed chylothorax. The association of operative procedure and the development of this complication were not significant.

Table 8: Post operative mortality

Procedure	No. of deaths	P Value
Ivor Lewis	1	IL vs TA,P=0.4690
Transabdominal	1	TA vs TH,P=0.3419
Transhiatal	1	IL vs TH,P=I.0000

As can be seen from the table 8 there were three deaths in the postoperative period in our study. However as can be clearly seen, no statistically significant association could be derived between the surgical modality used and the mortality.

Table 9: Hospital stay

Procedure	Mean hospital stay (days)	P value
Ivor Lewis	18.375 +/- 1.598	IL vs. TA <0.001
Trans abdominal	10.227 +/-1.771	TA vs. TH <0.01
Transhiatal	12.8 +/-0.8367	IL vs. TH <0.001

As can be seen from table 9, the patients stayed in the surgical wards for significantly longer duration following the Ivor Lewis technique when compared with the Transhiatal (p=<0.001) and transabdominal techniques (p=<0.001).
Also significantly longer operative stay was noted for the Transhiatal procedure when compared with Transabdominal technique (p=<0.01).

Anastomotic Recurrence

Anastomotic recurrence was noted in 11 patients during follow up with the highest no. of patients belonging to the transabdominal group.

Discussion

The mean age at presentation of our patients was 58.8 years. The youngest patient in our study was 43 years old and the eldest one 84 years of age. Khuroo *et al.,* (1992), found the mean age of occurrence of esophageal cancer in the Kashmiri population of 52 years. Ivan *et al.,* (2003), found the mean age to be 57 yrs at presentation. Our results are in accordance with the above mentioned data. Our study included 26 males and 9 females. The sex ratio in our study was 2.9: 1 in favour of males. The sex ratio in our study favourably matches with the following authors. Daly *et al.,* (2000) found a male: female ratio of 3:1 in their study once they evaluated patients with esophageal cancer for gender. Koshy *et al.,* (2004) preponderance of esophageal cancer in favour of males.

The most common presenting symptom in our patients was progressive dysphagia (77.14%), followed by weight loss (8.57 %) and loss of appetite (8.57 %).

Painful deglutition (2.85%) and regurgitant vomiting (2.85 %) were the other notable symptoms. Dysphagia is a symptom of advanced disease and when severe enough, more than 60 % of esophageal circumference is already infiltrated with cancer (Peters and Meester, 2005). So most of patients in our study presented with an advanced disease. Siewert *et al.,* (2000) found dysphagia to be the commonest presenting symptom in 80-95% of patients with esophageal cancer.

The most common histology encountered in the biopsy specimen and later on confirmed on the pathologic examination was adenocarcinoma (79.98 %), followed by squamous cell carcinoma (17.14 %) and others (2.85 %). Among adenocarcinomas the most frequent subtype was moderately differentiated adenocarcinoma (37.14 %).

There has been a worldwide increase in the incidence of adenocarcinoma of the esophagus, especially of the lower end which now constitutes the most common histology in many countries (Blot and Fraumeni, 1987). Our results also favour this trend of increasing incidence of adenocarcinoma of the esophagus (Pommier *et al.,* 1998), noted adenocarcinoma in 74.4 %, squamous cell carcinoma in 24.4 % and others in 1.3 % of patients who had esophageal resection performed. Visbal *et al.,* (2001) found adenocarcinoma as the predominant histology in 85.5% of patients operated for lower esophageal growths in which an esophagogastrectomy was performed by the Ivor Lewis technique. In their study the other histology was squamous cell (14.1%) and others (1%).

Operative Technique

Operative technique of the 35 patients included in our study who were subjected to an upper midline laparotomy 22 patients was operated via a transabdominal approach (17 males and 5 females). The growth, which was involving the abdominal part of esophagus only, was resected via the abdominal approach, widening the hiatus for achieving adequate proximal gross tumour free margin of 5 cm and making an esophagogastric anastomosis.

Complete abdominal nodal dissection was also performed routinely. In patients where the proximal stomach was also involved by the growth, distal esophagectomy was combined with a total gastrectomy and continuity maintained by a Roux en Y type anastomosis. A feeding jejunostomy was also performed routinely in all patients.

In 8 patients where the growth extended into the lower thoracic esophagus, a right postero lateral thoracotomy was also done and esophagogastric anastomosis made in the thorax. In addition to the abdominal nodes, in the patients mediastinal lymphadenectomy was also performed. In 5 patients with limited extension of the growth into the thorax but with respiratory co morbidities like copd, restrictive lung disease, a neck incision was made in addition to a laparotomy and anastomosis fashioned in the neck.

Neck nodes were dissected and sent for HPE. Ellis *et al.,* (1997), strongly advocated standard esophago-gastrectomy in 90% of patients with operable carcinoma of the esophagus or cardia. Siewert *et al.,* (2000), in their study concluded that appropriate surgical approach for carcinoma of lower end of esophagus and cardia remains controversial. Mariette *et al.,* (2002), were of the opinion that post operative mortality and morbidity and long term survival did not appear to be affected by the surgical approach.

Operative Time

The operative time was measured from making of the skin incision (or making of the first incision in case of IL and TH techniques) up to the closure of the last skin incision. For the Ivor Lewis resection, it was 350+/-30.706 min (range, 310-410 min) and included the time required for repositioning the patient for a thoracotomy after closure of the laparotomy incision. For a Transhiatal approach the mean operative time noted was 253+/-12.227 (range, 235-267) min and for the Transabdominal approach 200+/-19.669 min (range, 175-245). Goldmine *et al.,* (1993) found operative times for IL procedure to be 360 min and for TH approach 180 min. Chu *et al.,* (1997), noted mean operative times of 210 min for IL and 174 min for TH in their series.

Pommier *et al.,* (1998), found average operative time of 389 min and 275 min for IL and TH approach respectively. This difference was statistically significant (p =0.0001). Hulscher *et al.,* (2002), calculated the mean operative time of 360 min and 210 mins respectively for the Ivor Lewis and transhiatal operations. This difference was statistically significant ($p<0.001$). As can be seen, in our study statistically significant difference in the mean operative times was noted between the IL and TH techniques and between the IL and TA techniques. Similarly significant difference in the operative time was noted between TH and TA techniques. Our data are clearly in accordance with the published literature.

Intraoperative Complications

The operative morbidity of esophagectomy can range from intraoperative hypotension to fatal vascular injury. In our study there were a total of 8 complications (22.85 %). The highest no. of complications were in the transhiatal group (40 %) and included one patient with a pneumothorax, where a chest tube insertion was performed which was removed after 3 days after confirmation of lung expansion on that side. Another patient who was operated by the transhiatal method developed significant but transient systolic hypotension (sys BP< 80 mmhg).

In the Ivor Lewis group two complications were noted (25 %) with one patient having an iatrogenic thoracic duct injury. In another patient the azygous vein was injured. Both of these complications were recognized on table and while the thoracic duct was ligated, the azygous vein was repaired primarily.

In the transabdominal group the intraoperative complication rate was 18.18 % with 4 out of a total 22 patients having a complication. Two patients (9.09 %) had an iatrogenic splenic injury and both were subjected to a splenectomy. Another 2 patients developed a left sided pneumothorax and one needed insertion of a chest tube which was removed after 2 days. Another patient was managed conservatively. When considering the intraoperative complications no significant differences were observed between the Ivor Lewis and Transhiatal groups (IL vs. TH, P=1.000).Also there was no significant difference between the Ivor Lewis and Transabdominal groups (IL vs. TA, P=0.6452) and Transhiatal and Transabdominal groups (TH vs. TA, P=0.3031). Chu *et al.,* (1997), noted that intraoperative hypotension occurred more significantly in the transhiatal group.

Hulscher *et al.,* (2001) found no significant differences in the perioperative morbidity between the transthoracic and transhiatal procedures.

Conversion Rates

There were no conversions in our study and once proceeded all the three procedures were completed.

Operative Blood Loss

In our study significant differences were noted among procedures as regards the operative blood loss with the highest blood loss noted in IL technique and the lowest in the transabdominal technique. The average blood loss was 1900 +/-292.77ml (range, 1750-2500 ml) for Ivor Lewis approach. For the Transhiatal technique it was 1200+/-209.17 ml (range, 900-1450 ml)(ILvs.TH <0.05) (TAvs.TH <0.05) and 545.23+/-248.29 ml(range,300-1500) (IL vs. TA <0.05) for the trans abdominal approach. Goldfaden *et al.,* (1986), noted significant difference in the mean operative blood loss between the Ivor Lewis group (avg. 2510 ml) and Transhiatal approach (1187 ml) respectively. Hulscher *et al.,* (2002), in their study found the average operative blood loss to be 1900 ml for the Ivor Lewis and 1000 ml for the transhiatal

procedure. Our results are in accordance with them and clearly denote that operative morbidity in terms of blood loss is significantly higher in the Ivor Lewis group. The blood loss was lower for the Trans abdominal approach because of a single incision and least extensive dissection among the three modalities.

Respiratory Complications

Respiratory complications are the most common operative morbidity following esophagectomy. Pneumonia, basal atelectasis and pleural effusion predominate. Respiratory complications occurred in 11.42 % of patients in our study. One patient in the Ivor Lewis group had pneumonia (12.5 %). Another patient developed a pleural effusion (12.5%). Both of these patients recovered uneventfully. In the transhiatal group one patient developed pneumonia (20 %). In the transabdominal group one patient developed left lung basal atelectasis (4.54 %). The higher rates of pulmonary complications in the IL group may be due associated injury to the lungs and pleurae. Limited respiratory excursions on the side of thoracotomy due to pain and longer operative times with pooling up of respiratory secretions may add to the insult further. In addition these patients already had associated risk factors in the form of smoking. The routine insertion of a chest drain in IL procedure further entails a risk of infections. Transthoracic resections can be associated with transient deterioration of pulmonary function during one lung ventilation in the left lateral position. The higher rates of pneumonia (20 %) in the transhiatal group signify the extensive blunt dissection. Also pleural breach may occur during dissection. Finally the neck incision may hamper in effective respiratory movements. Our results match the published data in the world but are slightly higher due to a smaller sample size and our limited experience with these procedures. Goldminc *et al.,* (1993), in their study in 67 patients observed pulmonary complication rates of 20 % and 19 % for IL and TH techniques respectively. Rindani *et al.,* (1999), found the incidence of respiratory complications for Ivor Lewis and Transhiatal approach to be 25 % and 24 % respectively. Karl *et al.,* (2000), noted 19 % pulmonary complications for IL procedure in their series. Griffin *et al.,* (2002), reported a respiratory complication rate of 17 % for Ivor Lewis procedure.

Anastomotic Leak

Anastomotic leakage includes both clinical leakage and subclinical leakage (only seen radiologically) (Hulscher *et al.,* 2001). The incidence of anastomotic leakage in the Ivor Lewis group in our study was 12.5 % (1 patient). The leak appeared via the chest drain once the patient was given methylene blue on the 7th post operative day. The patient was managed conservatively with nil per oral and continuing with the jejunostomy feeds. A conray dye study performed one week later showed no evidence of leak and liquid orals were started and patient behaved well until his discharge from the hospital.

One patient (20 %) among the transhiatal group also developed a clinical leak on the 3rd post operative day and was subjected to re exploration with drain placement at the anastomotic site with primary closure of neck wound. The patient recovered uneventfully. Among the transabdominal group two patients (9.09 %) developed anastomotic leakage (one clinical and one radiological). Both were managed conservatively. One of these patients died on the 14th post operative day due to fulminant sepsis.

Anastomotic leakage is commoner after the cervical anastomosis because of the tension on the anastomosis and a more tenous blood supply of the part of stomach used for the anastomosis.[2]

Once Anastomotic leak rates among groups operated by various modalities were compared no significant differences were found in our study (IL vs. TA P=1.0000), (TA vs. TH, P=0.4735) and (IL vs. TH, P=1.0000). Our figures are in accordance with the data from other series. The incidence of leak following IL approach varies widely in literature. It seems that hospitals with large experience and high load of esophagectomies have lesser incidence of anastomotic leaks.

Lozac'h *et al.,* (1998), reported leak rates of 7.5 % and 13 % for IL and TH procedures respectively. Chlapik and Gasa (2000), reported anastomotic leak rate of 3.5 % in their patients following Ivor Lewis esophagectomy. Visbal *et al.,* (2001), in their study found leak rates of 9 % for IL approach. Griffin *et al.,* (2002), reported 4 % leak rate after Ivor Lewis procedure. Sarela *et al.,* (2008), reported a leak rate of 11.5 % for IL esophagectomies in their series. The higher incidence of anastomotic leak following the

transhiatal approach may be due to limited surgical experience of this procedure at our institution. Also smaller sample size may have given higher values. Also the patients in our series were operated in advanced stage of their disease thus adding to the morbidity.

Chylothorax

There were two patients in our study who developed this complication (5.71 %). One patient was operated upon by the Ivor Lewis technique and started with a leak through the chest drain on the 3rd postoperative day. The patient was managed conservatively. Another patient operated upon by the transhiatal technique developed chylous drainage on the 4th postoperative day. The patient was put on conservative management, TPN was started but the patient succumbed on the 14th postoperative day. There was a 50 % mortality due to the development of this complication in our study although no significant statistical association was found between the development of chylothorax and the operative procedure performed (IL vs. TH, P=1.0000, IL vs. TA, P= 0.2667, TA vs. TH, P=0.1852) Bolger *et al.,* (1991), noted a 46 % mortality associated with the development of chylothorax. Alexiou *et al.,* (1998), noted that only extensive dissection during esophagectomy appeared to be a risk factor for the development of chylothorax. Merigliano *et al.,* (2000), found no significant association (p=0.8) between the operative technique and development of chylothorax. As can be seen our results match those of the published data with regards to this complication.

Wound Infection

Wound infections were graded using the Southampton wound-grading system (Blot and Fraumeni, 1987). Overall 5 patients developed wound infection in our study. Two patients had a mild serous discharge requiring only frequent antiseptic dressings. Two more developed pus discharge requiring opening up of sutures and frequent saline and metrogyl washes till healing took place. One patient had a seroma only which resolved spontaneously. The wound infection rates following esophagectomy for cancer have been variedly reported. In our series the percentage of patients with wound infection was of the order of 14.28 %. The infection rates were 25 % for Ivor Lewis approach, 20 % for the Transhiatal approach and 9.09 % for the Trans abdominal approach. Pac *et al.,* (1993) noted wound infections in 21 % of patients operated by IL technique and 10 % of patients operated by TH approach. Our findings are in accordance with those of Gluch *et al.,* (1999) who reported a wound infection rate of 13.26 % in their series, with 18.2 % for the Ivor Lewis group and 10.8 % for the Transhiatal group. Gupta *et al.,* (2000) reported wound infection rates of 28.78 % in their series, with 44 % of IL and 18 % of TH resections developing infection and ascribed this finding to a smaller sample size. The increased infection rates in case of IL esophagectomy may be due to the fact that these patients are more nutritionally depleted because of larger tumour burden. Again longer operative times and a laparotomy and a thoracotomy incision may be added risk factors for development of wound infections. Higher rates of infection in the transhiatal group may be attributable to the smaller sample size.

Operative Mortality

The overall in hospital mortality (within 30 days) in our study was 8.57 % with 3 deaths. One patient died of ARDS secondary to a fulminant pneumonia (in Ivor Lewis group). Another patient died on the 15th postoperative day due to fulminant sepsis secondary to an anastomotic leak (in the Trans abdominal group). Another patient who was operated by the transhiatal approach died on the 14th postoperative day due to malnutrition secondary to chylothorax. The death rates in our series were 12.5 %, 20 % and 4.5 % for Ivor Lewis, Transhiatal and transabdominal procedures respectively.

Sahian *et al.,* (1986), reported 6.2 % mortality following IL approach and 13.3 % following transhiatal procedure for esophagectomy. De-Meester *et al.,* (1988), noted post operative mortality of 7 % for IL procedure. Goldminc *et al.,* (1993), reported a post operative mortality of 8.57 % and 6.25 % respectively for the IL and TH approaches. Chu *et al.,* (1997), noted 15 % mortality for Transhiatal approach for esophagectomy. Visbal *et al.,* (2001), reported a hospital death rate of 11 % for Ivor Lewis esophagectomy. Bhatti *et al.,* (2005), noted mean hospital mortality of 6.7 % after esophagectomy for

cancer. Chang *et al.,* (2008) found operative mortality of 13.1 % for IL and 6.7 % for TH procedures respectively.

The higher mortality rates for transhiatal and Ivor Lewis approaches in our study probably reflect the more advanced stage of tumour when the patients were operated. However no statistically significant difference could be obtained when comparing the mortality among different modalities. The limited experience with these procedures in our centre may probably play a role. In addition most of our patients were long term smokers and nutritionally depleted.

Hospital Stay

The patients in our study were discharged once they were ambulatory, tolerated orals and moved the bowels. The average hospital stay for all procedures in our study was 12.45 days. For the Ivor Lewis group it was 18.37 days (Range, 16-21 days). For the Transabdominal technique, the mean hospital stay was 10.22 days (range, 8-15 days). Patients in the transhiatal group were discharged from the hospital on an average after 12.8 days (range 12-14). Statistically significant difference in the mean hospital stay was noted between the Ivor Lewis technique and the Transhiatal procedure (IL vs. TH <0.001). Again patients in the Ivor Lewis group stayed in the hospital for significantly longer durations as compared to the Transabdominal technique (IL vs. TA <0.001). Patients in the Transhiatal group took longer time to leave the hospital as compared to those in whom a Transabdominal approach was performed (TA vs. TH <0.01). Our results favourably match the observation made by Sahian *et al.,* (1986) who noted a mean hospital stay of 17 days following Ivor Lewis procedure. Hattori *et al.,* (1968); Goldfaden *et al.,* (1986) noted average hospital stay of 22 days for the Ivor Lewis procedure. Gockel *et al.,* (2005) calculated 19 days as the mean hospital stay following Ivor Lewis technique. For the transhiatal approach average hospital stay was noted by Hattori *et al.,* (1968) at 12 days. Bhatti *et al.,* (2005) noted significantly shorter hospital stay for the transhiatal group. John *et al.,* (2006) noted significantly less hospital stay for the transhiatal approach with respect to the Ivor Lewis technique. For the Trans abdominal technique the average length of hospital stay was 10 days. It can be concluded here that Ivor Lewis technique is associated with a significantly longer hospital stay when compared to other procedures.

Anastomotic Recurrence

Out of the total 32 patients in our study who survived the postoperative period, 17 patients have completed a 1 yr follow up and another 7 patients are being followed up. 8 patients were lost to follow up. There were a total of 11 (34.37 %) documented anastomotic recurrences and these patients were referred to a specialised centre (SKIMS) for further management (stenting/ chemoradiotherapy). The highest %age of recurrences (38.09 %) were noted in the transabdominal group followed by the Ivor Lewis group (28.57 %). There was 1 recurrence in the Transhiatal group amounting to 25 %. These results were not statistically significant once the various surgical modalities were compared with each other.

Barbier *et al.,* (1988) noted 23 % anastomotic recurrence following the transhiatal approach .They also noted that almost half of the recurrences occurred within the first year following surgery. Hiroyuki *et al.,* (2005) in their study found a 22 % recurrence following the Ivor Lewis approach. Tam *et al.,* (1987) observed 16 % recurrence following Ivor Lewis procedure. They also noted that < 5 cm gross tumour free margin during resection was associated with a recurrence rate of 20 %. As can be seen the results in our study also are in accordance with the published literature. The higher values in our study may be accounted for by the smaller sample size. In addition, for the transabdominal approach higher values may signify inadequate proximal clearance of the tumour.

Conclusion

Carcinoma of the lower esophagus is a disease with significant morbidity and mortality and usually affects people in their 6^{th} and 7^{th} decades of life. Late presentation is the hallmark of this disease. Curative surgery remains the best form of treatment for lower esophageal cancer. In our study no significant differences were noted among the various surgical modalities employed, in terms of morbidity and mortality. Although Ivor Lewis technique is associated with significantly increased operative time, operative blood loss and hospital stay, this does not however translate into increased mortality. Because

of a small sample size and limited follow up, our data does not permit us to make a clear recommendation of one surgical modality over the other.

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