

## Research Article

# Minimally invasive esophageal surgery-standard of care-our experience

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## ABSTRACT

**Background:** Surgery is the most effective treatment for the resectable esophageal cancer of the middle & lower third and gastro-esophageal junction (GEJ) tumors. We hereby scrutinise our experience in minimally invasive esophageal surgery (MIES) to evaluate its safety and efficacy as an oncosurgical procedure.

**Methods:** The study included 99 consecutive patients. Depending on the location of the tumor, either thoracoscopic transthoracic esophagectomy (TTE) in prone position or laparoscopic transhiatal esophagectomy (THE) was planned. 2 field comprehensive nodal dissection were part of both the surgical procedures.

**Results:** 05 patients were excluded, 18 were inoperable and 12 had open surgery.

64 underwent MIES (THE-37, TTE-27), Male: Female-31:33. Nodal Harvest (nodes): THE-14.27, TTE-14.77. Margins (cm): THE-proximal (P) - 6.70, distal (D) -2.51, TTE: (P)-5.41, (D)-5.11.

30 days Morbidity (26): cervical leak-05, left vocal cord palsy-05, tracheostomy-03, respiratory insufficiency-03, aspiration-01, chyle leak-01, exploratory laparotomy-01, cardiac-02, stroke-01, surgical emphysema -01, abdominal wound Infection -03

30 days Mortality (1) –pulmonary embolus. Operative time (minutes): THE-234, TTE-322. Blood loss (ml/patient): THE-265, TTE-380. Hospital stays (days): THE-7.3, TTE-10.

**Conclusions:** 79% of properly selected & evaluated cases underwent MIES, with one Mortality and 26 events of morbidity. 6% required conversion. The procedure detected inoperability in 16% cases. The nodal yield, status of margins, operative time, blood loss and hospital stay indicates that MIES has a future to become a standard of care in the treatment of esophageal cancers.

**Keywords:** MIES, Cancer esophagus, GEJ, Nodal dissection, Margins

## INTRODUCTION

Esophageal cancer is the 8th most common cancer in the world. Significant regional variation exists in its incidence & pathology. There has been an increase in the incidence of adeno carcinoma worldwide, but squamous carcinoma remains the most common variant in the Asian countries. Surgery is the most effective treatment for the resectable esophageal cancer in the middle, lower third and gastro-esophageal junction (GEJ) tumors. Various studies have shown that minimally invasive esophageal

surgery (MIES) is associated with lower rates of complication and hospital stay.<sup>3-5</sup> There's still no Level I evidence to proclaim it as a standard of care for esophageal & GEJ cancers. The aim of this study is to put our limited experience in MIES to evaluate its safety and efficacy as an oncosurgical procedure.

## METHODS

The study has been conducted at Tertiary care Cancer Hospital & Research Centre, India. It includes 99

consecutive patients who were enrolled to one of the surgical oncology units at the hospital from January 2010 to August 2013 (44 months).

**Surgical selection:** Depending on the location of the tumor, one of the two Minimally Invasive surgical approaches was decided.

All the mid esophageal and the majority of the lower esophageal tumors (long segment, bulky disease, post neo adjuvant) underwent thoracoscopic transthoracic esophagectomy (TTE).

Almost all of the GEJ tumors and few of the lower esophageal tumors (short segment disease, patients with co morbidities and high operative risks) underwent laparoscopic transhiatal esophagectomy (THE).

2 field comprehensive nodal dissections were part of both the surgical procedures.

The study had been designed to evaluate the efficacy of MIES in the form of:

1. Diagnostic modality: the role of thoracoscopy and laparoscopy in detecting loco regional (LR) advance and metastatic disease not diagnosed on conventional staging investigations.
2. Tumor factors: Age & sex distribution, location, histopathology.
3. Adequacy: nodal harvest, status of margins.<sup>8,9</sup>
4. Safety and Quality Indicators (short term outcomes): Morbidity and mortality (30 days)<sup>10,11</sup>, operative time, blood loss and hospital stay.

#### **Evaluation protocol:**

The patients presented mostly with partial or complete dysphagia. A standard staging protocol was followed, which included upper gastro intestinal endoscopy with biopsy, CT scan abdomen with chest and routine blood evaluation. The bronchoscopy was done for the patients with tumors in the mid esophagus. All the patients underwent performance status evaluation in the form of cardiovascular and pulmonary function assessment to ascertain the anesthetic fitness for the surgical procedure. Whole body PET-CT scan was used only in patients with borderline operability and post neo adjuvant settings.

**Patient optimization:**<sup>12</sup> Prior to surgery the patient underwent nutritional assessment and its improvement. Rigorous pulmonary rehabilitation in the form of breathing exercises was initiated. They have a direct bearing on reducing the post-operative pulmonary complications.

#### **Anaesthesia:**

All the patients received hypotensive general anaesthesia

with fluid volume restriction. The lung isolation and single lumen intubation were not required, since thoracic dissection was done in the prone position. Epidural catheter was placed prior to the induction in all the patients. The position of the catheter varied slightly with the procedure planned. It was T5-6 for TTE and T8-9 for THE.

#### **Patient position and port placements:**



**Figure 1: Thoracoscopic transthoracic esophagectomy (TTE).**

**TTE** (Figure1): The patient is placed in a prone position with a sandbag below the chest to achieve the optimal curvature of the DL spine. The thoracic esophagus is accessed through the right thorax and three ports were used. The optic port (10 mm) is placed in the 7<sup>th</sup> intercostal space (ICS) in the posterior axillary line. The right hand working port (10 mm) at the 5<sup>th</sup> ICS (Parascapular) and the left hand port (5 mm) is placed in the 9<sup>th</sup> ICS forming an equidistant triangle between the three ports. The intra thoracic insufflations with CO<sub>2</sub> are maintained at 7 mm of Hg. The primary assessment of the thoracic cavity is done to confirm the operability and to rule out the metastatic disease.

**THE** (Figure 2): The supine position is employed both for the THE and the second stage of TTE, after completing the thoracic esophageal mobilization. A sand bag is placed between the scapular blades for neck extension. Straight stirrups are used to keep the legs apart at less than 60 degrees.

Total of five abdominal ports are placed in the supra umbilical portion of the abdomen. The optical port (10 mm) is placed at the umbilicus. Two working port (5 mm) are placed along the right and left mid clavicular line triangulating with the optic port. An epigastricport (10 mm) is placed for gas insufflations and liver retraction. A left subcostal or flank port (5 mm) is put for stomach retraction and dorsal dissection. Intra-abdominal insufflation with CO<sub>2</sub> is done at 14mm of Hg. The primary assessment of the abdomen is done to confirm operability and to rule out the metastatic disease.



**Figure 2: Port positions- laparoscopic transhiatal esophagectomy (THE).**

### **Operative steps:**

#### *Thoracic dissection (prone)*

The mobilization of the esophagus started at the level of carina. The azygous vein forms the anatomic landmark. The mediastinal pleura are opened up just beneath the vein and the mediastinal nodes are cleared along with the periesophageal fatty tissue. The azygous vein and the bronchial arteries are preserved. The entire esophagus is dissected from carina to hiatus safeguarding the pulmonary vein and the main stem bronchus, starting anteriorly and then dissecting posteriorly. The thoracic duct when identified at the lower part of the posterior dissection is ligated. The dissection is concluded by completing the partial mobilization of the supraazygos part of the esophagus for about 5 cm.

#### *Abdominal dissection (supine)*

It's started along the lesser curvature of the stomach. A comprehensive nodal dissection with the clearance of tissues along the coeliac, common hepatic, splenic and left gastric territory is done. The left gastric artery is ligated at its origin. The right crus are exposed. The hiatus is not breached at this point to avoid the loss of pneumoperitoneum. The retro gastric dissection is carried out proximally till the left crus is exposed and the short gastric vessels are ligated. Then the dissection is carried out along the greater curvature, safe guarding the gastroepiploic arcade and completing the mobilising of the stomach from the posterior bed and ligating the remaining short gastric vessels. After the complete gastric mobilization, the hiatus is opened by ventral and dorsal dissection to communicate with the mediastinum in TTE. In THE, the dissection around the thoracic esophagus is done almost up to the carina.

#### *Neck dissection*

A 4cm transverse left neck incision is taken for cervical esophagus mobilisation. The left recurrent laryngeal nerve is identified and safeguarded. Maintaining an adequate proximal margin, the esophagus is transacted

and the specimen is pulled down and delivered through the minilap wound.

#### *Mini laparotomy*

About 4-5cm supra umbilical mini laparotomy incision is taken for the delivery of the specimen and the conduit preparation. A total Kocherisation of the duodenum along with the fashioning of a drainage procedure- pyloromyotomy or pyloroplasty is done.

The gastric conduit is made, either by hand sewn technique or by linear staplers. The conduit is pulled up to the neck and anatomised with cervical esophagus- an end to side, single layer with vicryl 3-0. Occasionally 60 mm linear stapler is used to widen the anastomosis. The naso-gastric tube is retained across the anastomosis.

The abdomen is closed after a jejunostomy tube (JT) is placed and a tube drain is kept in the Morrison's pouch. Bilateral intercostal drains are placed in the chest.

#### *Post-operative management*

The majority of the patients were extubated on the same day. The post-operative pain relief was provided by epidural infusion and intravenous analgesics.

All the patients were given antithrombotic prophylaxis with Low Molecular weight Heparin (LMWH) and bilateral lower limb compressive stockings. A good glycaemic control and adequate hydration were maintained along with the fluid and electrolyte supplementation.

All the patients were made ambulatory on the first post op day (POD). Aggressive chest physiotherapy and breathing exercises were resumed. They received broad spectrum antibiotics for 5 days. The trial JT feeds were started from the 1<sup>st</sup> POD and by the 3<sup>rd</sup> POD; they were receiving the full feeds. All the tubes were removed by 3<sup>rd</sup> - 5<sup>th</sup> POD.

The patients were started with clear liquids orally from 7<sup>th</sup> or 8<sup>th</sup> POD and the oral contrast study was done only if indicated on the 7<sup>th</sup> POD. If all the parameters were within the normal range, the patient was discharged from the hospital by POD 7<sup>th</sup>-10<sup>th</sup> with JT. It was subsequently removed during the follow up visits when patients were taking reasonably well orally.

#### *Data Analysis*

*Patients excluded (18):* 3 were found inoperable on evaluation. One patient with resectable disease had co morbidities and was sent for radiation therapy. 10 patients were taken up for upfront open surgery in view of previous laparotomy, loco regionally advanced disease and comorbidities precluding MIES. 2 of these patients were found inoperable. 4 patients though underwent the MIES procedure was excluded based on the final histopathology

report, which showed gastric malignancy in 3 & leiomyoma esophagus in the other.

*Patients selected (81):* After evaluation, 81 patients were chosen to undergo the MIES procedure. 13(16%) of these patients were detected to have loco regionally advance disease on diagnostics copies (thoracoscopy-8, laparoscopy- 5) and hence were not operated.<sup>6</sup> MIES was attempted on the remaining 68 patients. 64 (94%)patients successfully underwent one of the two MIES procedures. The other 4 (6%) patients required conversion to the open procedure. Thus 64 (79%) of selected patients successfully underwent the MIES.

*The causes of inoperability:* THE - liver metastasis (3), mesenteric deposits (2).

TTE - disease encasing bronchus, carina and pulmonary vessels or adherent to pericardium and lung.

## RESULTS

64 patients underwent MIES (THE-37, TTE-27),

### Tumor factors:

1. Sex distribution: Males-31 (THE-19, TTE-12), Females-33 (THE-18, TTE-15).
2. Age (years): Males-53 (30-69), females-52.5 (28-78).
3. Symptom duration: 3.4 months (15 days-12 months)
4. Location: Mid esophagus-12, low esophagus-20, GEJ- 31, synchronous - 1(lesion at 22 & 32 cm).

80% (51/64) of tumors were located at the lower esophagus and GEJ.

5. Surgery based on tumor location: THE: 37 (low-09, GEJ-28)
6. TTE: 27 (mid-12, low-11, synchronus-01, GEJ-03)
7. Final histopathology: Squamous carcinoma was present in 39 (61%) patients. 24(37%) had adeno carcinoma, whereas no residual tumor was noted in one patient (post neo adjuvant).

### Adequacy MIES:

To evaluate the adequacy of the MIES procedure, two parameters were used; nodal harvest and the margin status. To further enhance the creditability of the evaluation, the patients in each operative group were divided into two periods- Period I (THE: 0-18, TTE: 0-13), Period II (THE: 19-37, TTE: 14-27).The overall results as well as the results in the two periods were evaluated.

- Nodal Harvest (Table 1)

The mean overall nodal harvest were 14.27 and 14.77 nodes respectively for the THE and TTE. On evaluating the two periods separately, we found 35% improvement in the nodal harvest in THE group from 11.94 in the period I to 16.10 in the period II. For the TTE group the improvement was even better from 11.69 to 16.92 nodes of 45 %.

**Table 1: Nodal harvest.**

	Period I	Period II	Overall
THE Patients	11.94 (01-25) 01-18	16.10 (03-57) 19-37	14.27 (01-57) 01-37
TTE Patients	11.69 (05-23) 01-13	16.92 (06-29) 14-27	14.77 (05-29) 01-27

**Table 2: Margin status.**

	Margins	Period I	Period II	Overall
THE patients	Proximal	5.71 (0.8-11.0)	7.57 (3.6-13.0)	6.70 (0.8-13.0)
	Distal	1.91 (0.5-3.6)	3.08 (0.5-7.0)	2.51 (0.5-7.0)*
		01-18	19-37	01-37
TTE patients	Proximal	5.53 (2.0-12.0)	5.30 (1.5-9.0)	5.41 (1.5-12.0)*
	Distal	3.73 (1.0-8.0)	6.50 (3.5-14.0)	5.11(1.0-14.0)**
		01-13	14-27	01-27

\*One Margin close-Revised

\*\*One Margin Positive

• Margin Status (Table 2)

The proximal and the distal margins of the two surgical procedures were evaluated. Except the distal margin in the THE group, the proximal margins in both the group and the distal margin in the TTE group were beyond 5.0 cm.

THE: The overall proximal margin was 6.70cm and the distal margin was 2.51 cm. The period II showed marginal improvement in the distal margin (3.08 cm) compared to period I (1.91 cm).

TTE: Both the margins in this group were satisfactory. The overall proximal margin was 5.41 cm and the distal was 5.11 cm.

**Safety MIES-** Minimally Invasive Esophageal Surgery (Table 3)

**Morbidity** (30 days): 26 events of morbidity were noted. 73% (19/26) of these were surgically related.

**Mortality** (30 days): There was one event of mortality on POD 5 in the TTE group. The cause of death was pulmonary embolus.

**Quality Indicators:** The respective parameters of the THE and TTE groups were:

1. Operative time (mean): 234 (150-330) and 322 (210-450) minutes.
2. Blood loss (average): 265 and 380 cc.
3. Hospital stay (mean): 7.3 (05-18) and 10.0 (05-30) days.

ICU- (intercostal space) stays (mean): 2.2 and 2.8 days

**Table 3: Morbidity (30 days).**

Complications			THE	TTE	Overall	%	
Surgical	Anastomotic Leak (Neck)	Major	02 *	-	02	05	7.8%
		Minor	02 **	01 **	03		
	RLN Palsy	03	02	05	7.8%		
	Tracheostomy	01	02	03	4.7%		
	Chyle Leak	-	01	01	1.6%		
	Expl. Lap.	01***	-	01			
	A.W. Infection	03	-	03			
	Emphysema	-	01	01			
			12	07	19	30%	
	Medical	Respiratory	Aspiration	-	01	04	6.3%
Bronchospasm			-	01			
Pneumonia			02	-			
Cardiac		M.I.	-	01	02	3.1%	
		Arrhythmias	-	01			
Cerebral	Stroke	01	-	01			
Overall		03	04	07			
Overall		15	11	26	40%		

\* Major Leaks POD 06 & 16-Neck explored, leak lateralized

\*\*Minor Leaks POD 08, 21 & 22-treated conservatively

\*\*\* POD 03-peri JJ leak

**Mortality** (30 days): There was one event of mortality on POD 5 in the TTE group. The cause of death was pulmonary embolus.

**DISCUSSION**

Squamous Carcinoma is the predominant pathological variant with a slight female preponderance. 80% of the tumors were located at the lower esophagus & GEJ. After evaluation, 79% of enrolled patients were found suitable

to undergo MIES. The procedure detected inoperability in 16% patients with normal metastatic work up. 94% patients successfully underwent MIES in which the procedure was attempted with one mortality and 26 events of morbidity. Only 6% required conversion.

The mean Nodal yield were 14.27 & 14.77 for THE and TTE group which improved further in the II<sup>nd</sup> Period to 16.10 & 16.92, respectively. Except for the distal margin in THE group, the other three margins were beyond the recommended 5.0cm limits.

The current study showed satisfactory results when compared to historical cohorts<sup>11</sup> (Table 4) and review studies<sup>4</sup> (Table 5) with regards to the short term perioperative outcomes.

**MIES compared to the open procedures:**

**Table 4: Review of the literature: historical cohorts.**

Study	Mortality (%)	Morbidity (%)				
		Pulmonary	RLN palsy	Leak (Neck)	Leak (chyle)	Tracheostomy
Aikyam 1994	2.0	31	10	0	-	-
Fujita 1995	2.0	6	70	11	-	21
Kato 1991	2.6	9	14	33	-	-
Nishi Hara 1998	3.1	19	56	6	-	53
Altorki 2002	15	26	9	11	-	4
Ando 2000	1.7	22	-	13	-	-
Verba 2012	-	20	10.6	6.6	-	-
Nakamura 2008	3.3	19.6	1.6	9.2	-	-
Sharma 2010	2.75	16	12.5	2.4	0.9	8.2
Present 2013	1.56	6.3	7.8	7.8	1.6	4.7

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**Table 5: Result comparison with review studies.**

	Systematic Review Gemmill 2007 (weighted means)	Case control studies (10) Combined Data (weighted means)		Current Study
	MIE (n= 1398)	Open (n=494)	MIE (n=616)	MIE (n=64)
L.N. retrieval	17.6	20.2	23.8	14.27/14.77 16.10/16.92(n=33)
Complications (%)	46.2	60.4	43.8	40
Pulmonary (%)	13.2	22.9	15.1	6.3
Mortality (%)	2.3	4.5	1.9	1.56
Operative time (minutes)	281	324	334	234/322
Blood loss (ml)	316	577	312	265/380
Hospital stay (days)	11.0	19.6	14.9	7.3/10
ICU stay (days)	-	7.6	4.5	2.2/2.8

**Minerva Chirurgica 2009;64 (2):135-46**

**CONCLUSION**

The short term perioperative outcomes in the terms of morbidity, mortality, nodal yield, status of margins, mean operative time, blood loss, hospital stay and recovery from surgery are satisfactory and as per the standard norms. The oncological outcome can be further improved by overcoming the initial learning curve, gaining more experience with the technique and with the upgradation of the optics and instrumentations.

MIES has a future to become a standard of care in the treatment of esophageal cancer as the surgeon's world over gather more experience with the technique.

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