mm Endo Paddle Retract™ (Figure 1). Five or ten mm 30-degree laparoscope was utilized. e diaphragmatic crura was opened from le to right. e short gastric vessels and the posterior gastric vessels to the base of the le crus were divided selectively, depending on the intraoperative ndings. e hernia sac was dissected initially from the hiatus, followed by complete circumferential dissection from the mediastinal structures. Mediastinal lipomas were present in four patients. ese were dissected and excised. e size of the herniation of the stomach into the chest was estimated based on both preoperative studies, and intra operatively, a er stomach was returned back to the intra abdominal cavity. Esophagus was dissected in the mediastinum as high as possible. Both vagus nerves were identi ed and preserved. Intra abdominal esophageal length of minimum 2.5 cm was accomplished with extensive mediastinal dissection; there was no need to perform vagotomy or Collis gastroplasty for the lengthening of the esophagus in this study. e size of the hernia was measured as a distance between right and le crus, and anterior to posterior distance between hiatal apex and posterior decussation of the right and le crus (Figure 2). Posterior crural closure was performed with interrupted Ethibond endoknot sutures SKU EX10G (Ethicon Inc.) (Figure 3). Additional anterior sutures were placed selectively on the crura depending on intra operative situation.

e biologic gra for crural reinforcement was chosen based on the availability and the cost of the product. ree di erent types of gra were used, including acellular human dermal collagen (AlloMax™) in six patients, cellular porcine dermal implant (Permacol™) in one patient and porcine urinary bladder matrix (Acell MatriStem®) in four patients. e size of the gra was either 10 cm x 15 cm or 7 cm x 10 cm, depending on the size of the defect. A er the gra was hydrated for 30 minutes, it was fashioned into “U” shape (with or without creation of a keyhole) and placed as an onlay patch posterior to the esophagus over the crural closure. Gra was secured to the diaphragm with hernia stapler (Figure 4). ENDOPATH® EMS 10 mm Endoscopic stapler (Ethicon Inc.) was used for securing of AlloMax™ gra , ProTack Autosuture 5mm stapler (Covidien Ltd) for Permacol™, and SECURESTRAP® Absorbable Fixation Device (Ethicon Inc.) for Acell Matri Stem®. Fundoplication performed in ten out of eleven patients, using anterior Dor technique in eight patients, Nissen in one patient, and Toupet in one patient.

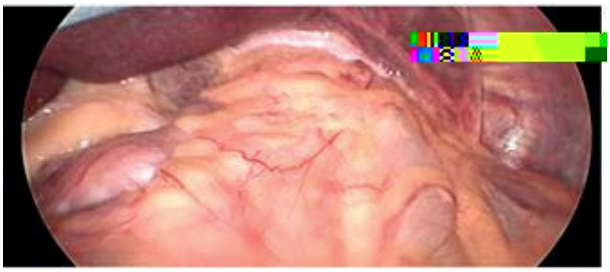


Figure 1: Type 4 hiatal hernia with stomach and colon in the chest. Left lobe of the liver rejected cephalad.

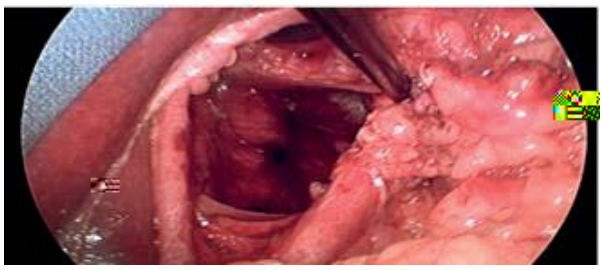
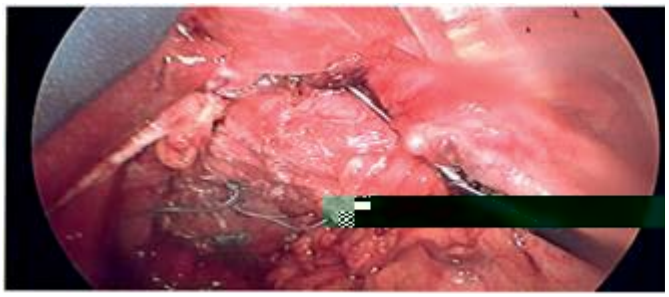


Figure 2: large hiatal defect. Esophagus rejected to the left.



R sults

Eleven patients underwent laparoscopic repair of large hiatal hernias with the reinforcement of the crural closure with biologic gra . ere were six females and ve males, mean age was 55.4 years (± 8.7), mean BMI was 32.5 (± 7.5). Chest pain was the most common symptom (91%), followed by dysphagia (82%), epigastric abdominal pain and heartburn (64% each), shortness of breath (55%), nausea and vomiting (4%), hematemesis (2%) and weight loss (1%) (Table 1). Preoperative evaluation included esophagogastro duodenoscopy in eight patients, computer tomography in all patients and upper gastrointestinal study in nine patients. Mean operative time was 244.6 minutes (± 71.7), and mean length of stay was 3.3 days (± 1.8). Six patients had the reinforcement of the crura with AlloMax™, one patient with Permacol™, and four patients with Acell MatriStem®. In all cases right and le crus were approximated. ree patients were operated under the urgent settings, with suspected diagnosis of gastric volvulus, based on clinical presentation and radiological ndings. ere was no evidence of acute gastric ischemia intraoperatively. e average size of herniated stomach in the chest was 62% (± 22.7), with entire stomach herniated inside the chest in two patients. Eight patients had type III hiatal hernia, two patients had type IV, and one patient had type II. Two patients with type IV hiatal hernia had colon together with stomach in the chest (Figure 5). Secondary procedure was performed in three patients along with hiatal hernia repair, including laparoscopic cholecystectomy in two patients, and umbilical hernia repair in one patient. Mean sizes of the hiatal defect was 7.7 cm (right to le) (± 1.1), and 6.4 cm (anterior to posterior) (± 0.8). Only one perioperative complication (9%) was encountered and included bleeding from le

Patient (n)	Gender	BMI*	Age	SYMPTOMS							
				Epigastric pain	Chest pain	SOB **	Dysp-hagia	Acid re f ux	Nausea/ vomiting	Hemat-emesis	Weight loss
1	M	46	52	yes	yes	yes	yes	yes	yes	no	no
2	F	37	57	yes	yes	no	yes	yes	no	no	no
3	F	27	53	yes	yes	yes	yes	no	no	no	no
4	F	36	67	yes	yes	no	yes	yes	yes	no	no
5	M	22	68	no	yes	no	no	yes	no	yes	no
6	F	31	51	no	yes	yes	yes	yes	no	no	yes
7	F	34	42	yes	yes	no	no	yes	no	no	no
8	M	28	49	no	no	yes	yes	no	no	no	no
9	M	24	45	no	yes	no	yes	no	no	no	no
10	M	30	62	yes	yes	yes	yes	no	yes	no	no
11	F	43	63	yes	yes	yes	yes	yes	yes	yes	no
Total 11	**M=**5 **F=**6	**Mean** 32.5(Ñ 7.5)	**Mean**55.4 (Ñ8.7)	**%** 64	**%** 91	**%** 55	**%** 82	**%** 64	**%** 4	**%** 2	**%** 1

*Body mass index Ĵ r ex Ĵ Ĵ A بخي

Patient (n)	Length of surgery (min)	Defect size (R to L)x(A x P), cm	Size (%) of stomach in the chest	Mesh type	Fundo-plication	EBL ** (ml)	Com-plica-tions	Media-stinal-lipoma	Secondary operation	Hermia type	LOS * (days)
1	305	8 x 7	70	Acell	Dor	500	bleeding	yes	no	3	6
2	146	7 x 7	50	Acell	Dor	10	no	no	no	3	2
3	213	9 x 6	60	Acell	no	10	no	no	no	4	2
4	240	8 x 7	50	Acell	Dor	50	no	no	no	3	2
5	191	6 x 6	40	Allomax	Nissen	50	no	no	UHR***	3	2
6	320	9 x 6	100	Allomax	Dor	10	no	no	no	4	4
7	207	8 x 6	40	Allomax	Dor	10	no	yes	Lap chole	2	6
8	370	8 x 5	80	Allomax	Dor	50	no	yes	no	3	4
9	171	7 x 6	40	Allomax	[illegible]	[illegible]	no	no	no	3	1
10	315	9 x 8	50	Permacol	Dor	10	no	yes	no	3	5
11	213	6 x 6	100	Allomax	Toupet	10	no	no	Lap chole	3	2
Total 11	**Mean** 244.6 (Ñ 71.7)	**Mean** 7.7 (Ñ 1.1) x 6.4 (Ñ 0.8)	**%** 62	**6 + 4 + 1 = 11**	**8 + 1 + 1 + 1 = 11**						

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