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General Surgery

LAPAROSCOPIC PLICATION OF EVENTRATION OF LEFT HEMIDIAPHRAGM: CAPNOTHORAX OVERCOMES TECHNICAL DIFFICULTIES

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ABSTRACT Diaphragmatic eventration is a relatively rare condition with an incidence of 1 in 10,000 live births. It is defined as a permanent elevation of a hemi diaphragm without defects of continuity. Recurrent respiratory distress and chest infections are common presenting complaints5.

5 adult symptomatic patients of eventration of left hemidiaphragm were operated over a period of 7 years from 2010 to 2017 by a single surgeon. They presented with moderate to severe respiratory distress and recurrent pneumonia. Diagnosis of eventration suspected on clinical examination was confirmed on X-ray chest and CT scan. Later also revealed abdominal viscera migrating to left hemi thorax. Laparoscopic plication of left hemi- diaphragm was done. Capnothorax created in a case of severe eventration, greatly eased the technical difficulties in plication. Average hospital stay was 5 days. In two patients, dual mesh was added to strengthen the repair. After surgery, patients were given intensive respiratory exercises and all the patients showed complete recovery from dyspnea over a follow up period of 3 months. One patient, however, had partial recurrence after 6 months. He was explored and proper plication was done.

KEYWORDS : diaphragmatic, eventration, capnothorax, plication thoracoscopy, laparoscopic.

INTRODUCTION

Eventration of diaphragm is a rare congenital developmental defect of the muscular portion of the diaphragm, which appears attenuated and membranous, maintaining its normal attachments and its anatomical continuity[1]. Eventration can be unilateral or bilateral, partial or complete. It is more common in males, and involves more often the left hemi diaphragm. There is an abnormal elevation of the dome of diaphragm allowing abdominal viscera to migrate to hemithorax compressing ipsilateral lung, and by mediastinal shift, the opposite lung.

In a newborn, eventration with large unilateral elevation of the diaphragm may be associated with secondary hypoplasia of the homo-lateral lung.

Eventration in older children and in adults is usually caused by diaphragmatic palsy. However there are a number of patients in whom a cause cannot be explained (idiopathic eventration). Clinical manifestations range from asymptomatic to life threatening respiratory distress. Gastrointestinal symptoms may be present if there is migration of abdominal viscera into thoracic cavity[2]. Long-lasting diaphragm paralysis may lead to cor pulmonale [3].

Surgical treatment of eventration of hemidiaphragm needs plication by tight imbrication of the entire hemidiaphragm by abdominal or thoracoscopic approach. It can be open or laparoscopic. It should be selected on the basis of patient anatomy, comorbidities, and surgeon experience.

MATERIAL AND METHODS

All 5 patients were male in 20 - 68 years age range. They had common history of recurrent respiratory infection, breathlessness and dyspnea since 3-5 years. One patient came with life threatening reparatory distress and had to be put on ventilator in ICU and was operated after stabilization. Patients were thoroughly investigated including pulmonary function tests. Chest X-ray showed varying degree of raised dome of left diaphragm with mediastinal shift to the right side. CT scan was done in 4 cases and MRI chest in 1 case, for confirming diagnosis, degree of eventration, abdominal viscera occupying left hemi-thorax and any lung pathology. 4 patients had moderate, one patient had severe eventration of left diaphragm.

Patients were operated under general anesthesia in supine position with both hands by the side. 30° reverse Trendlenberg position was given after pneumoperitoneum. Surgeon stood on right side and monitor was kept on left side of patient. 5 ports were used. A 10 mm camera port above umbilicus, 2 operating 5 mm ports in mid-clavicular lines in both hypochondria, 5 mm epigastric port for liver retractor and 5 mm port in anterior axillary line in left flank for assistant was made.

Laparoscopic plication by 6-10 sutures was done. The first stitch was placed centrally in the tented dome and as far posteriorly as possible. Traction on the first stitch facilitates exposure for two or three subsequent deeper stitches. Plication was started in the posterior portion of the hemidiaphragm and continued towards the anterior diaphragm. Later, several non-absorbable monofilament sutures were woven or pleated medially and laterally to effectively reduce redundancy and flatten the diaphragm.

Capnothorax was created by a small hole in tented dome of diaphragm by hook electro cautery, in the patient with severe eventration since thinned out diaphragm receded too much cranially due to pneumoperitoneum. It was then easier to manipulate loose and floppy diaphragm and plicate incorporating the hole also, with barbed and prolene sutures Chest tube was inserted and removed 3 days later. In 2 patients, a composite mesh was used to strengthen the plication. Mean operating time was 180 minutes. Average hospital stay was 5 days. All patients showed remarkable recovery and were relieved of respiratory symptoms over follow up in 3 months. However after 6 months, 1 operated patient of moderate eventration developed partial recurrence of eventration with subacute upper GI obstruction. Patient was explored by upper midline incision, after reduction of viscera, proper plication was done to correct the recurrence.

DISCUSSION

Eventration is a rare congenital disorder of muscular portion of diaphragm without lesion of the diaphragmatic innervation. The intact but thinned out diaphragm is largely composed of fibrous tissue though the muscular insertions are normal. It has been attributed to abnormal myoblast migration to the septum transversum and the pleuro-peritoneal membrane[1].

Newborns usually present with acute respiratory failure, but in adults, the most common symptoms are increasing dyspnea, recurrent respiratory infections though, many may remain without any symptoms.

Diaphragmatic paralysis due to phrenic nerve palsy is more common[4]. Muscular layer becomes atrophic and diaphragm gets elevated over period of time[6-8].There may be shift of the mediastinum to the contralateral side and show paradoxical movement that preventing normal expansion of the lung. Earlier, Graham et al[7], reported shortness of breath as the main symptomatic feature of diaphragmatic paralysis.

The diagnosis of paralysis or eventration of hemidiaphragm is suspected on clinically and X-ray chest. During fluoroscopy, sniff test,

diaphragmatic excursion is evaluated. Normally, the diaphragm moves caudally, but in patients with diaphragmatic paralysis and eventration, the diaphragm shows paradoxical movement.

CT scans confirms diagnosis, migration of abdominal viscera. It also helps to rule out the presence of a cervical or intra thoracic tumor as the cause of phrenic nerve paralysis or an infra or supra diaphragmatic process as the cause of hemidiaphragm elevation.

A restrictive pattern on spirometer i.e. low forced vital capacity [FVC] and low forced expiratory

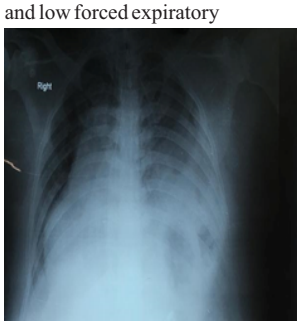

Fig. 1 Preoperative X-Ray Chest

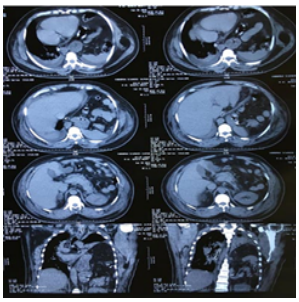

Fig. 2 Preoperative MRI Chest

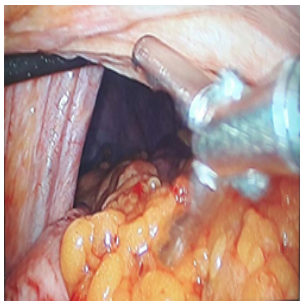

Fig. 3 -Abdominal viscera in left hemi thorax

Fig. 4- Thinned and tented left dome of diaphragm after pneumoperitoneum

Fig. 5 - One of many plicating sutures

Fig. 6 - Post operative X-ray Chest

volume in one second [FEV_1] is the norm due to diaphragmatic dysfunction.

An elevated hemidiaphragm or paradoxical motion, per se, does not merit surgery in the absence of significant dyspnea.

Symptomatic patients need plication procedure to bring diaphragm to its normal inspiratory position, reversing paradoxical motion so the lung may expand more readily relieving the respiratory symptoms[9].

Simansky et al.[14], reported that the indication for surgery for all children was failure to wean from ventilator support, while the indications for surgery in the adult group were ventilator dependency and symptomatic dyspnea that cannot be attributed to any other cause e.g. poorly controlled primary lung or heart disease.

Various approaches have been employed for diaphragmatic plication, including Open transthoracic, VATS, open transabdominal, laparoscopic and robotic assisted transabdominal or transthoracic (may be aided with laparoscopy).

Morison[11] described in 1923, a series of 9 patients of elevation of the diaphragm, repaired through an open thoracotomy. For decades, this approach was the mainstay of surgical treatment for diaphragmatic plication.

In VATS technique, redundant diaphragm is resected by help of stapler. There is, however, risk of damage to the abdominal viscera through such a thin diaphragm. It was found more popular approach to diaphragmatic repair, with long-term follow-up data attesting to its efficacy as comparable to that of open thoracotomy[13,15]

Podgaetz *et al*[10] reported a preference for the laparoscopic approach over the more common thoracoscopic approach, citing its increased workspace (allows retraction of the abdominal organs), better visualization, avoidance of selective lung ventilation and reduced postoperative intercostal nerve pain (associated with a mini- or full thoracotomy incision) as attractive benefits of the laparoscopic approach.

Widespread adoption of thoracoscopic and laparoscopic approaches to diaphragmatic plication has been hindered by the technical skill set required to perform these operations safely.

Transabdominal robot-assisted diaphragmatic plication with deliberate capnothorax overcomes technical challenges of laparoscopic approach. It has a steep but rapid learning curve with good clinical outcome. Mean operating room time for this procedure dropped by approximately 100 minutes after the first 3 cases in a series of 22 patients over 3.5 years, Sreeja Biswas Roy et al[12].

In Laparoscopic approaches [6-8], the procedure is performed under general anesthesia, with a single-lumen endotracheal tube. The abdomen and lower lateral chest wall are prepared and draped to allow access for chest tube placement. Steep reverse Trendelenburg positioning helps bringing down abdominal viscera and optimize exposure of the posterior portion of the hemi diaphragm.

Capnothorax by perforating redundant diaphragm by hook cautery, equalized chest and peritoneal pressure which forces the thinned out diaphragm to become loose and floppy and hang down greatly facilitating plication [10,12].

Laparoscopic diaphragmatic plication in only 3 patients was first reported by Huttl et al[9]. Larger series were published later with long term follow up; 22 patients by Freeman et al[13], 19 patients by Higgs et al[10] and 22 patients by Versteegh et al[3]. They emphasized that most important result was significant and long-lasting improvement in the dyspnea, quality of life, and pulmonary function tests.

All of our patients had significant dyspnea and gastrointestinal symptoms. Laparoscopic plication was done with non-absorbable sutures. We created capnothorax in one patient of severe eventration which allowed plication with greater ease. Postoperatively, patients were subjected to intense pulmonary exercises.

Relative contraindications to a laparoscopic approach include previous extensive abdominal surgery, morbidly obese patients who pose technical challenges due to fatty hepatomegaly or excessive omental fat in the left upper quadrant.

There can be rupture with herniation or recurrence of eventration if there is breakdown of plicating sutures or staples. We had recurrence in one patient.

CONCLUSION

Adoption of the laparoscopic, thoracoscopic or robotic approach for diaphragmatic plication is largely a matter of surgeon preference, experience and availability of equipments. Diaphragm should be rendered as taut as possible whatever technique is used.

Laparoscopic approach has advantage of increased workspace, better visualization and allows safe retraction of the abdominal organs.

Capnothorax by cautery puncture of raised and tented diphragm results in loose and floppy diaphragm overcoming the technical difficulty in laparoscopic plication of cranially shifted dome due to pneumoperitoneum. Therefore, it is strongly recommended in all the cases.

Further randomized larger studies are warranted to determine whether

the laparoscopic approach indeed offers both short and long-term benefits over other approaches.

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