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EFFECT OF ENDOSCOPIC COMPONENT SEPARATION TECHNIQUE WITH LAPAROSCOPIC MESH HERNIOPLASTY ON POST-OPERATIVE PULMONARY FUNCTION AMONG PATIENTS OF LARGE MIDLINE VENTRAL HERNIA, VISITING A TERTIARY CARE HOSPITAL OF NEW DELHI.

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ABSTRACT Large midline ventral hernia repair, in the settings of modern healthcare, is a challenging prospect for the surgeon. Endoscopic component separation technique is a novel approach for such cases resulting in tensionless abdominal wall reconstruction. It results in improvement of the anterior abdominal wall muscle function and therefore better functioning of the diaphragm. To study the impact of endoscopic component separation technique with laparoscopic IPOM plus on pulmonary function thirty patients were reviewed for the size and cause of the hernia, pre-operative, intra-operative and post-operative morbidity and mortality with assessment of pulmonary complications in the immediate post-operative period and at follow up after one-month. An appreciable, but non-significant improvement in pulmonary function was demonstrated among study participants. The "endoscopic components separation technique" seems useful for the reconstruction of large abdominal wall hernias and tends to improve pulmonary function. A further research with larger sample size may strengthen the findings.

KEYWORDS : Ventral Hernia, Endoscopic, Component Separation, Pulmonary Function

Introduction

Ventral hernia defects are either spontaneous or acquired secondary to surgical incision or penetrating trauma to the wall. Based on the defect site, these hernias can be in midline or laterally.

Management of midline ventral hernias is aimed at reducing the contents back into the peritoneal cavity and repair of the defects. Large ventral hernia repair, in the settings of modern healthcare, is a challenging prospect for the surgeon. Ramirez et al[1] described a technique for reconstructing large midline ventral hernias and named it as Open Component Separation Technique (OCST). In this, the abdominal wall is released at least 10 cm on either side of defect thus facilitating the closure of the large midline abdominal wall defect with local tissue advancement of unilateral or bilateral rectus muscle complex towards midline.

After the advent of laparoscopy, Rosen et al[2] described an Endoscopic Component Separation Technique (ECST), in which a endoscopic technique is used to release the external oblique, with fewer wound complications. With further advent in techniques, an approach was developed which combines endoscopic component separation technique with laparoscopic intraperitoneal on lay mesh (ECST with Lap IPOM) repair of large ventral hernias. This has significantly reduced the morbidity and recurrence.

Pulmonary function in general is known to be adversely affected by abdominal surgeries. Reductions in functional residual capacity, vital capacity, inspiratory capacity, expiratory reserve volume have been studied & demonstrated previously[3]. The severity of adverse effects on pulmonary function has been attributed to the site of surgery, elevation of the diaphragm, diaphragmatic dysfunction, decreased function of abdominal respiratory muscles, altered restrictive pattern of breathing and post-operative blocking of lower respiratory tract with mucous plugs[4].

In the setting of large midline ventral hernias, managing the hernia closure with mesh but without closing the defect leads to further deterioration of pulmonary function because of inability to fully utilize the abdominal muscles of respiration[5]. Alterations in diaphragmatic function, use of respiratory accessory muscles, and pulmonary toilet are negatively affected by abdominal wall reconstruction, predisposing the patients to respiratory complications[6]. The pulmonary complications following abdominal wall surgery can manifest as atelectasis, bronchospasm, pneumonia, bronchitis, pleural effusion, pulmonary embolism, ARDS and respiratory failure[7].

Also, in very large ventral hernias which are associated with huge amount of abdominal contents residing outside the main abdominal cavity leading to loss of domain, repositioning of these contents back inside the abdominal cavity may lead to compression of intra-abdominal structures and interfere with the proper functioning of the diaphragm.

Hence, Midline closure of the linea alba following component separation for large ventral hernias leads to improvement in the anterior abdominal wall muscle function and this is expected to lead to better respiratory efforts and thus improve functioning of the respiratory system.

Due to paucity of documentation in the literature, only few studies are available assessing the effect of endoscopic component separation technique with laparoscopic mesh hernioplasty for large ventral hernia repair on pulmonary function. Through this prospective study, we assessed the effect of endoscopic component separation technique with laparoscopic mesh hernioplasty for large midline ventral hernia repair on post-operative pulmonary function (FEV1).

Materials and Methods

A prospective observational study was conducted among all patients of midline hernia (primary and secondary) who were planned for ventral hernia repair using endoscopic component separation with laparoscopic mesh hernioplasty at a tertiary care Hospital of New Delhi. A feasible sample size of 30 patients was included in the study. Patients of age less than 18 years and greater than 80 years, lateral ventral hernia patients, pregnant and lactating patients, patients having a stoma, patients with severe respiratory or cardiac co-morbidities (ASA: III - V), patients having active infections, sinus or fistula at hernia site related to previous surgery, morbidly obese patients with BMI greater than 37.5 kg/m2, and patient in whom we were unable to create intra-peritoneal working space due to extensive adhesions were excluded.

All patients were clinically evaluated, and information gathered regarding various demographic and pre-operative variables. All routine investigations and pre-anaesthetic work up was done. All patients underwent pre-operative pulmonary function tests to assess the pre-operative pulmonary function. A pre-operative MDCT was done for each patient and the size, location of defect along with the Component Separation Index (CSI) was assessed.

Eligible patients underwent endoscopic component separation with laparoscopic mesh hernioplasty. Intra-operative assessment of pulmonary function was done by measuring peak airway pressure, end inspiratory airway pressure and end expiratory airway pressure at the time of creating pneumoperitoneum and then at time of closure of abdominal cavity.

Angle of diastases (AD) was calculated in a transverse section of MDCT abdomen in which aorta was kept at a fixed point and the angle was calculated between the medial free edges of the rectus abdominis muscle of both sides. Component Separation Index (CSI) was calculated by dividing the AD by 360.

Each patient was reviewed preoperatively and at 1 month follow up

and were assessed for change in the parameters mentioned above. All data were collected & means and percentage of various outcome parameters were calculated and analysed using SPSS software.

A written and informed consent was taken from all patients. Study was approved from the Institutional Ethical Committee of Lady Hardinge Medical College and associated RML Hospital, New Delhi.

Results

The study included 30 patients with age group from 32 years to 64 years (Mean: 47.40±8.41 years). 73.33% of patients were between the ages of 36-55 years. The study group comprised of 11 males and 19 females.

The mean operating time was 200.33 ± 15.86 minutes, ranging from 180 minutes to 240 minutes. In all cases, composite mesh (Proceed) was used.

The mean length of hospital stay varied from 4 to 14 days (Mean: 5.40±1.73 days). None of the patients developed a post-operative recurrence during the said period of stay. There were no mortalities in the study.

Among the post-operative complications, most notable was one case of hematoma formation in which, the patient was taken up for re-operation, mesh was removed, midline approximated with interrupted non-absorbable sutures, wound was left open and managed with twice a day dressing. It was secondarily closed after 40 days. There were no iatrogenic enterotomies in the study.

15 patients (50%) demonstrated an increase in Forced Vital Capacity (FVC) at 1 month follow up when compared with the pre-operative values, while it decreased in 11 patients and was the same as pre-operative value in 4 patients. The pre-operative mean **FVC** in the study was 2.93 ± 0.16 and the corresponding value was 2.96 ± 0.22 at one month follow up. This demonstrated a small but non-significant increase following component separation.

13 of the patients (43.33 %) had improvement in the Forced Expiratory Volume in the first second ($FEV_{1)}$ post-operatively, while 6 had no change and 11 showed a decrease in FEV_1. The mean pre-operative mean value of **FEV_1** in the study was 2.37 ± 0.151, which increased to 2.39 ± 0.227 1 month post operatively. However, the increase in the volume was statistically not significant**.**

Residual volume (RV) increased in 10 patients (33.3%), remained the same in 13 patients and showed a decrease in 7 patients when compared with the pre-operative values. The mean value of RV pre-operatively was 1.19 ± 0.127 and the post-operative value at 1 month was 1.21 ± 0.112. The slight increase observed in the study was not statistically significant.

Similarly, there was an appreciable but non-significant increase in the Total Lung Capacity (**TLC)** values, with the pre-operative mean to be 4.12 ± 0.228, and the 1-month postoperative value to be 4.17 ± 0.292. When compared to the pre-operative values only 43.33 % of our patients (13) had improvement in TLC post-operatively, while 6 had no change and 11 showed a decrease in TLC.

Because the increase in TLC was greater than the increase in RV, the post-operative value of **RV/TLC** demonstrated a statistically non-significant decrease post operatively (0.2873 ± 0.02106) when compared to the pre-operative value (0.2883 ± 0.02056).

The pre-operative mean value of partial pressure of oxygen (**paO_2**) was 98.47 ± 7.779, which increased to 103.71 ± 8.210. This increase and resultant improvement in the oxygenation was considered to be statistically significant. 24 patients had shown improvement in paO_2 at one month post-operative follow up compared to pre-operative values, while in 6 patients, paO_2 had shown a decrease. SpO_2 was seen to increase in 26 patients (86.67%) of the patients when compared to pre-operative numbers. However, the rest of the ABG analysis showed no significant increase or decrease in the post-operative values.

Peak airway pressure (PAP) demonstrated a mean value of 23.53 ± 2.662 at the time of creating pneumo-peritoneum (which has been considered as the starting point) in our study. The mean value of **PAP** at the time of closure of abdomen (ending point) was 26.73 ± 3.657. The increase in the PAP was statistically significant and demonstrated deterioration in respiratory function during the intra-operative period. All the patients in our study showed an increase in PAP at the time of closure of abdomen.

Similar statistically significant increase was demonstrated in the mean value of End Inspiratory Airway Pressure (**EIAP**), which had a mean value of 21.07 ± 2.420 at the start and 24.37 ± 3.068 at the end. 93.33% patients (28) had an increase EIAP at the time of closure of the abdomen and only 2 patients had no change in EIAP.

Again, the end expiratory airway pressure (**EEAP**) also demonstrated a significant increase from the mean value of 3.37 ± 3.068 at the start to 6.03 ± 3.864 at the end. It increased in 22 of our patients (73.33%), while remained the same in 8 patients. This increase in the airway pressures at the closure suggested that there was more need of mechanical ventilation and the, hence, a deterioration in respiratory function. However, at 1 month follow up, the respiratory function showed appreciable but statistically non-significant improvement as demonstrated by the pulmonary function tests. Furthermore, there was a significant improvement in the paO_2at 1 month post-operatively.

Discussion

Large midline ventral hernias are a technical challenge for the surgeon. Component separation is a recent advancement in the management of such hernias. Open component separation has low recurrence rates but is associated with a higher wound complication rates and skin ischemia and necrosis. Performance of component separation by the endoscopic technique aims at reducing the complication rates with a similar rate of recurrence.

The study participants included 19 females as compared to 11 males. Female preponderance was presumed to be due to incisional hernias occurring secondary to caesarean section surgeries. Operating time is considered as a modality for comparing different surgical techniques since it is a predictor of the overall outcome of the patient. In the study reported by Agnew et al[8], the mean operating time was 3.9 hours with a minimum time of 2 hours, while Blatnik et al[9] had a median length of operation to be 260 minutes (ranging from 65 minutes to 630 minutes). In our study we found that the mean operating time was 200.33 ± 15.86 minutes, ranging from a minimum of 180 minutes to a maximum of 240 minutes. The mean time for performing endoscopic component separation was 51.83 ± 7.598 minutes and the mean time for mesh fixation after fascial approximation 149.17 ± 11.302 minutes.

K.K. Jensen et al[12] in their systematic review and meta-analysis which included 5 studies found that 18% of cases undergoing ECS developed wound complications, the most common of which was surgical site infection. While in our study, only 2 patients (6.67%) had surgical site infections. One patient (3.33%) developed skin necrosis following infection of hematoma, followed by abscess formation and subsequent mesh infection.

According to the study conducted by Agnew et al[8] in 2010, there were no statistically significant differences detected in FVC, FEV_1or MVV. Intra-operative peak airway pressures remained within the normal range, and did not change significantly from preclosure to post closure. In other study by K.K. Jensen et al[12] observed that there was no significant increase in the FVC or FEV_1 at 1 year follow upon their study group. However, significant increase & improvement in expiratory function was demonstrated at 1 year follow up by exhibiting increase in % PEF & % MEP. In the present study, it was observed that in the intra and peri-operative period there was a slight deterioration in the pulmonary function. However, at 1 month follow up no significant changes in PFT was observed. In fact, there was a tendency towards improvement in the pulmonary function. This needs further validation with a larger study.

The pre-operative mean FVC in our study was 2.93 ±0.16, which demonstrated an appreciable but non-significant increase with the post-operative 1 month follow up corresponding value to be 2.96 ± 0.22. The mean pre-operative mean value of FEV_1 in the study was 2.37 ± 0.151, which increased to 2.39 ± 0.227 1 month post operatively. However, the increase in the volume was statistically not significant. Residual volume also showed an increase in the follow up period, with the mean pre-operative value to be 1.19 ± 0.127 and the post-operative value at 1 month to be 1.21 ± 0.112, but the resultant increase was not statistically significant.

Similarly, there was an appreciable but non-significant increase in the TLC values, with the pre-operative mean to be 4.12 ± 0.228, and the 1-month post-operative value to be 4.17 ± 0.292. Because the increase in TLC was greater than the increase in RV, the post-operative value of RV/TLC demonstrated a statistically non-significant decrease post operatively (0.2873 ± 0.02106) when compared to the pre-operative value (0.2883 ± 0.02056). The pH showed a statistically significant decrease from pre-operative mean value of 7.40 ± .032, to 7.38 ± 0.21. Peak airway pressure demonstrated a mean value of 23.53 ± 2.662 at the time of creating pneumoperitoneum (which has been considered as the starting point) in our study. The mean value of PAP at the time of closure of abdomen (ending point) was 26.73 ± 3.657. The increase in the PAP was statistically significant and demonstrated deterioration in respiratory function during the intra-operative period. Similar statistically significant increase was demonstrated in the mean value of end airway inspiratory pressure, which had a mean value of 21.07 ± 2.420 at the start, to 24.37 ± 3.068 at the end.

Again, the end airway expiratory pressure also demonstrated a significant increase from the mean value of 3.37 ± 3.068 at the start, to 6.03 ± 3.864 at the end. Both pre-operatively and post-operatively, we subjected our patients to vigorous chest physiotherapy and incentive spirometry. Our study demonstrated more encouraging results as compared to the earlier studies, which might be due to appropriate intra-operative and post-operative management with respect to the respiratory function as it was our main aspect of study.

Conclusion

Large midline ventral hernia repair is an enthralling challenge for the surgeon. Endoscopic component separation technique with laparoscopic intra-peritoneal onlay mesh repair is a novel advancement in the setting of abdominal wall reconstruction & large hernia repair techniques. It also acts by restoring the lost abdominal domain and increasing the intra-abdominal volume, thereby reducing the adverse impact of large hernia repair on the respiratory system.

We acknowledge certain limitations of our study. This study was a prospective observational study and the patient selection was non-randomized. We believe that there is a need of a comparative randomized trial to further substantiate and validate our results. Moreover, there is a need of a longer follow up to look for delayed improvement in pulmonary function with endoscopic component separation technique.

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