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Muscle-sparing posterolateral thoracotomy for esophageal atresia Vogt Type 3b

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KEYWORDS

Esophageal atresia,
Muscle-sparing,
Posterolateral,
Skin crease,
Thoracotomy

ABSTRACT

Background: Posterolateral muscle cutting thoracotomy is the gold standard approach to repair esophageal atresia with distal tracheoesophageal fistula. This technique is associated with morbidities in terms of poor motor and aesthetic outcomes. We aim to share our experience with muscle-sparing skin crease incision posterolateral thoracotomy for esophageal atresia Vogt type 3b.

Methods: It was a retrospective observational study conducted over a period of 3 years and 6 months from January 2016 to June 2019 at two tertiary care teaching institutes. All patients with esophageal atresia having distal tracheoesophageal fistula were included.

Results: Fifty-nine neonates underwent muscle-sparing thoracotomy, with 23 males and 36 females. The 34 (58%) neonates had low birth weight. Anorectal malformation (ARM) was the most common (6) associated major malformation (18). Intraoperative findings included long gap EA (6), right aortic arch (RAA, 3), aberrant vessels (1), and long upper pouch (1). Conversion to muscle cutting approach (during early learning curve) was performed in 8 cases i.e., long gap EA (3), RAA (2), Subglottic stenosis (2), others (1). No intraoperative complication was encountered; postoperative seroma formation (related to the approach) was observed in 2 (3.4%) neonates. Most of the patients achieved satisfactory functional and aesthetic outcomes.

Conclusion: Muscle-sparing skin crease incision posterolateral thoracotomy is a viable approach for repair of esophageal atresia with distal tracheoesophageal fistula. The technique is easy to perform with adequate exposure and provides satisfactory functional and aesthetic outcomes with relatively minimum morbidity.

INTRODUCTION

Posterolateral muscle cutting thoracotomy is the gold standard approach to repair esophageal atresia (EA) with distal tracheoesophageal fistula (TEF).[1] This technique is associated with morbidities in terms of poor motor (impaired arm and shoulder movements) and aesthetic (larger incisions) outcomes.[2,3] Also, the thoracoscopic approach is a highly advanced level of care. It has a long learning curve and requires 2mm /3mm sized thoracoscopic instruments. Muscle sparing thoracotomies have been purported to result in lesser morbidity to the patient compared to the muscle cutting approach.[1-3]

This study was aimed to evaluate the outcomes of muscle-sparing posterolateral thoracotomies for EA Vogt type 3b with (1) Primary objective i.e. completeness of procedures and (2) Secondary objectives (to assess): (a) the adequacy of exposure and access to both esophageal ends, (b) motor outcomes, (c) aesthetic outcomes, (d) intraoperative and postoperative complications, and (e) difficulties encountered.

METHODS

This was a retrospective observational study performed over a period from January 2016 to June 2019 at two tertiary care teaching institutes.

INCLUSION CRITERIA: All neonates with EA with distal TEF.

EXCLUSION CRITERIA: Reoperations / failed first surgery / failed primary anastomosis.

At admission, baseline blood investigation including complete blood counts, serum electrolytes and liver

function tests (assessment of jaundice and preoperative optimization), and radiographs with red rubber catheter in situ were performed. A thorough clinical and radiological assessment was done, including ultrasonography of the abdomen and ECHO when feasible.

The 'long gap EA' was defined by the gap length between the upper and lower esophageal segments of > 3 cm.[4,5] Presence of a 'long upper pouch' was considered when the upper esophageal pouch was at T8 vertebral level or near the level of the diaphragm.[6]

Muscle-sparing skin crease incision right posterolateral thoracotomy technique for EA: The positioning of the neonate was almost similar to that of the standard posterolateral muscle cutting approach. The patient was placed in the lateral position with right-side-up. The patient was immobilized with the help of small rolls, cotton pads, and paper tapes. A small axillary roll was placed under the lower axilla and chest wall that increases the intercostal space on the contralateral side. The arm was drawn forward, extended to about 90-120°, and placed by the side of the head on a tailor-made armrest. The peripheral pulses were monitored by the pulse-oximeter of the extended arm and limbs.

The proposed site of incision was marked. Incision (5-7 cm) was given approximately 1cm below the tip of the scapula. It extended from the mid-axillary line to midway between scapula and spine, approximately over the fifth intercostal space. Skin flaps were created on either side over the body of the latissimus dorsi and Serratus anterior muscle. Dissection was performed medially to the anterior border of the latissimus dorsi muscle; a space was created between the Latissimus dorsi and Serratus anterior muscle. Latissimus Dorsi was retracted laterally and the belly of the Serratus anterior was elevated, retracted medially and superiorly with retractors [Figure 1].

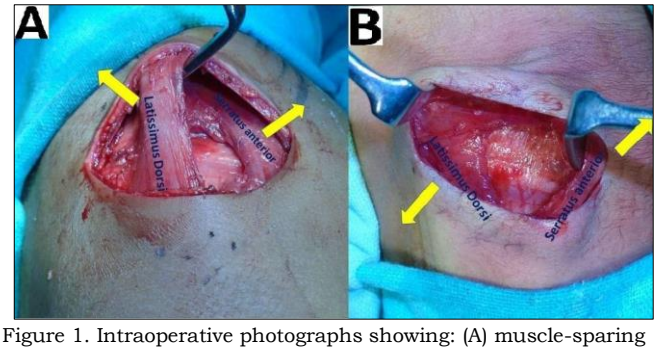

Figure 1. Intraoperative photographs showing: (A) muscle-sparing thoracotomy with Latissimus Dorsi being retracted laterally (by retractors) and belly of the serratus anterior retracted medially; (B) post-dissection and before entering the rib cage.

Finally, access to the rib cage was achieved from the fourth or fifth intercostal space (ICS). An extrapleural dissection was performed. The azygos vein was ligated and cut. TEF was transfixed and ligated with 5-0 silk sutures and cut. Esophageal end-to-end anastomosis was performed with one layer 5-0 Polyglycolic acid sutures (PGA) [Figure 2]. After completion of the anastomosis, an intercostal tube (infant feeding tube Fr. 10) connected with an underwater seal bag was placed. Ribs approximation was done using absorbable 3-0 PGA sutures; muscles were realigned and layered closure of subcutaneous tissue skin was performed.

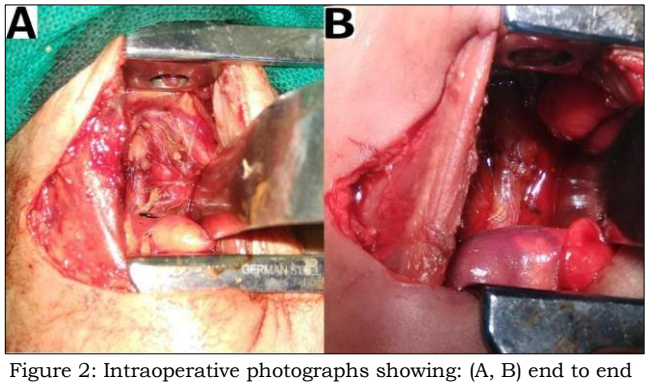

Figure 2: Intraoperative photographs showing: (A, B) end to end esophageal anastomosis with completely spared latissimus dorsi and serratus anterior muscles.

Postoperative care was supported in the neonatal intensive care unit. Extubation was performed as per the institutional policy. Broad-spectrum antibiotics were prescribed. All the patients were subjected to postoperative chest X-rays in the evening and as and when required. Esophagogram was performed on the 6th /7th postoperative day. Clinical and radiological assessment of thorax and lung expansion was performed at one and 3 months. Clinical examination was done for the presence of deformity of the chest wall, rib crowding, presence of scoliosis, and lung expansion on auscultation and findings were confirmed on chest radiographs. Aesthetic outcomes and motor outcomes were also assessed at one and three months, respectively. The aesthetic assessment included the size of the scar, presence of abnormal scar, wound infection (if any), etc. The motor assessment consisted of the presence of any atrophy of chest wall muscles, restricted upper limb movements (weakness), presence of any obvious scapular deformity.

The statistical analysis was obtained with a statistical package for social sciences (SPSS) version 10.0 for Windows. A "p" value of less than 0.05 was considered significant.

RESULTS

Fifty-nine EA patients were managed with muscle-sparing right-sided thoracotomy [Table 1]. There were 36 females with M:F ratio of 1:1.6. The day of admission ranged from 1 to 12 days (median = 2 days). The weight of neonates at presentation ranged from 1500 to 3000 grams (mean weight = 2281 ± 397 grams) with 58% having low birth weight [Table 1]. Associated malformations/defects/syndromes were

seen in 22.03% (13) patients. A total of 18 associated malformations were present in 13 patients. The most common associated malformation was Anorectal Malformations (ARMs) as shown in Table 1. One patient needed mechanical ventilation pre-operatively.

Table1: Demographic characteristics of patients in the study

Gender distribution	**Frequency N= 59**	**Percentage**
Males	36	61%
Females	23	39%
Birth weight	**Frequency N= 59**	**Percentage**
≥2500 grams	25	42%
< 2500 grams (Low Birth Weight)	34	58%
Associated malformations or anomaly	**Frequency N= 59**	**Percentage**
EA (Vogt Type 3b) Isolated	46	77.96%
EA (Vogt Type 3b) associated with Malformations/ Defects/Syndromes	13	22.03%
Associated Malformations /Defects /Syndromes	**Frequency N= 18**	**Percentage**
Anorectal Malformations 1. Persistent Cloaca 2. High type (Male) 3.Vestibular fistula 4. Low type (Male)	6 1 1 2 2	33.33%
Cardiovascular 1. ASD 2. Right Aortic Arch	5 2 3	27.77%
Cleft palate and/or Cleft lip	2	11.11%
Subglottic Stenosis	2	11.11%
Hernia of Umbilical Cord	1	5.55%
Down Syndrome	1	5.55%
Pneumoperitoneum	1	5.55%

Long gap EA was seen in 6 patients, right aortic arch (RAA) in 3, aberrant vessels in 1, and long upper pouch in 1. Conversion to muscle cutting approach (during early learning curve) was performed in 8 (13.6%) cases owing to long gap EA – 3, right aortic arch (RAA) – 2, subglottic stenosis – 2, and others (anesthesia / cardiac-related with multiple episodes of intraoperative desaturation) – 1. Adequate exposure was achieved in 86.4% (51/59) neonates with good access to both esophageal ends. No intraoperative complication (related to the approach) was encountered. Mean intra-operative thoracotomy time was 60 minutes (ranged from 45 minutes to 75 minutes). Additional Procedures were performed in 3 neonates: reduction of intestinal contents and umbilicoplasty in hernia of the umbilical cord (1), left transverse loop colostomies in persistent cloaca (1), and high type male ARM (1).

The mortality rate was 32.2% (19/59). The mortality rate was not related to the muscle-sparing approach. Pneumonic consolidation (4) and septic shock (4) were the most common cause of mortality in the patients in our series [Table 2]. Postoperative complications were seroma formation (related to the approach) and wound infection (not related to the approach) seen in 2 (3.39%) patients each; they were managed by repeated aspiration and dressing. Anastomotic leak with spontaneous closure was noted in one patient. There was no recurrence of TEF.

Most (38/40) of these patients achieved satisfactory aesthetic outcomes at 4 weeks (1 month). Out of 40 patients, 2 were lost to follow-up. The average size of the incision scar was 6 cm (5.5 to 6.5 cm). A major part of the scar lies hidden under the arm. There was no wound infection / abnormal scar.

Table 2: Causes of mortality in the patients in our series

Cause of death	**Frequency**	**Percentage**
Pneumonic consolidation	4	6.78%
Septic shock	4	6.78%
Cardiovascular malformations (Large ASD with RAA)	3	5.08%
Anastomotic leak (Long gap EA)	3	5.08%
Subglottic stenosis	2	3.39%
Low birth weight with associated ARM	2	3.39%
Pneumoperitoneum (Etiology could not be ascertained)	1	1.69%
Total	**19**	**32.2%**

Most (38/40) of the patients achieved satisfactory motor/ functional outcomes; lung expansion was satisfactory. There was no impairment of arm and shoulder movements at the 3-month follow-up. There was no deformity of the chest wall (related to the approach). The mean hospital stay was 10± 1.75 days (range 7-14 days).

DISCUSSION

EA with TEF has an incidence of approximately 1 in 2500 to 4500 live births.[7] The malformation poses significant technical and long-term challenges for pediatric thoracic surgeons. The enhanced survival of the neonates with EA with TEF is dependent on a number of aspects like advanced neonatal intensive perioperative care, including antibiotics and better surgical techniques and operating skills and management of the complications. These factors, especially the surgical approach play an important role to prevent/reducing the risk of long-term adverse sequelae.[7]

Posterolateral muscle cutting thoracotomy in neonates is associated with enhanced exposure

during repair of EA with distal TEF.[1-3] With this approach, the access can be easily and quickly extended if greater exposure becomes necessary.[8] This approach is at the expense of cutting latissimus dorsi and Serratus anterior muscles which are the major chest wall muscles.[8] It is purported to be moderately time-consuming, increased potential for blood loss, associated with impaired lung function, shoulder and chest wall deformities, and winging of the scapula.[8,9] The choice of approach is guided by satisfactory access required to perform a safe procedure, good cosmesis, and better postoperative outcomes (recovery).[8]

The muscle-sparing thoracotomy is a substitute to the muscle cutting thoracotomy as it results in lesser morbidity to the neonate, less postoperative pain, less analgesic use, and better respiratory and lung functions.[10]

Several techniques of muscle-sparing thoracotomy are described in literature after the first reported by Browne (1953) with vertical axillary thoracotomy.[11] The procedure was also described by Noirclerc et al. (1973).[12] Mitchell et al. (1976) suggested a lateral muscle-sparing thoracotomy.[13] Later Bethencourt and Holmes (1988) described muscle-sparing thoracotomy by conventional posterior thoracotomy approach.[14] Bianchi et al. (1998) in the same year and later Kalman and Verebely (2002) defined the technique of axillary skin crease, muscle-sparing right lateral thoracotomy in pediatric patients.[2,3] They performed operative procedures that were restricted to the upper 2/3rd of the thoracic cavity. The operations included EA with TEF and patent ductus arteriosus.[2,3]

With our approach, procedures are not restricted to the upper 2/3rd of the thoracic cavity. Our approach is a variation of the technique of Bethencourt and Holmes.[14] We employed (1) a similar-sized incision as in standard muscle cutting thoracotomy, (ii) an approach anterior to the Latissimus Dorsi muscle along its anterior border instead of the posterior approach (between the Trapezius and Latissimus Dorsi muscle.

With our approach, there is limited exposure at the base of the lung and distal esophagus, but after the initial learning curve and experience with the technique, this difficulty is also obviated. A suitably long and fine-tip forceps and needle holder are essential for dissection of the TEF and anastomosis of the esophagus. The finer instruments have also been suggested by authors from Japan.[1]

Mean intra-operative thoracotomy time was 60 minutes which is comparable with other studies and also with the muscle cutting procedure for EA. Opening time is longer because of the creation of skin flaps and forming a space anterior to the Latissimus Dorsi muscle. On the other end, closing time is smaller as muscles need only realignment and not reapproximating of muscle edges.[9,10,15,16]

Improved motor (muscle) functions with muscle-sparing thoracotomy have been reported by various studies.[17-19] A meta-analysis comparing both muscle-sparing and muscle cutting techniques with 1083 patients showed statistically significant improved shoulder function (internal rotation of shoulder) with the former technique.[8]

Among the complications, seroma formation is one of the most common postoperative complications in most of the muscle-sparing series, especially with the posterolateral approach.[8,9,16,20-22] In our study, it was seen in 3.39% (2) patients and were managed conservatively. Post-operative wound infection was seen in 3.39% (2) patients which is low as compared to other studies.[1] In our study, none of the patients suffered a neurological injury to the arm or shoulder. Transient arm paralysis has been reported with an axillary incision.[1] Our procedure provides satisfactory aesthetic outcomes as the incision is of similar size as compared to the standard approach.

The survival percentage in the present study (67.8%) is better as compared to the previous one (29.89%) as per the study published in the year 2016 from the department.[23] The improvement in survival is related to the conglomeration of multiple factors with improved perioperative neonatal intensive care and surgical approach.

The merits for the pediatric thoracic surgeon are that this approach can act as a bridge between muscle cutting and the thoracoscopic approach. It has a short learning curve. It is useful when there are resource constraints. Also, the approach is suitable in a high-volume center with a burden of a large caseload with time constraints. The other pros are once conversion from thoracoscopic surgery is required, a muscle-sparing approach may be contemplated. Authors recommend that before attempting the muscle-sparing technique, the surgeon must obtain sufficient experience with the muscle cutting approach. Muscle sparing thoracotomy resulted in complete preservation of function. It has been advocated in infants to avoid major structural deformities with growth. It allows the availability of muscle flaps (chest wall) for future use.[1]

The limitation of the present study was the limited duration of follow-up. This was due to resource constraints and geographical factors. Long-term follow-up is mandatory for comprehensive motor assessment. Also, the sample size was small; a larger cohort of patients for the study is being contemplated in the future. The strength of the study was that all

the thoracotomies were performed by the same surgeon.

CONCLUSION

A muscle-sparing thoracotomy is a viable approach for the repair of EA with distal TEF. The technique is safe, easy to perform, easily reproducible with satisfactory operative exposure (86.4%). This approach provides satisfactory functional and aesthetic outcomes with relatively minimum morbidity. We recommend muscle-sparing skin crease incision posterolateral thoracotomies for EA.

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