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Original Article

A 10 Year, Single Centre Experience to Assess Role of Negative Suction in Resolution of Persistent Postoperative Air Leak for Empyema Thorax in Paediatric Patients

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Abstract

Objectives: To evaluate whether external negative suction is more advantageous than only water seal in pediatric patients developing post-operative persistent air leak undergoing decortication for empyema thorax.

Methods: A retrospective analysis was done of all patients being admitted for empyema thorax at our centre from 2010 – 2019. Of these, total 180 patients with stage 2 and 3 empyema were identified and evaluated closely. Age distribution, sex prevalence, investigations performed, and treatment received was noted. Postoperatively patients developing persistent air leak (PAL) were compared with respect to grade of empyema, surgery performed, and postoperative negative suction applied or not. Their time to resolution of air leak after first 4 days post operatively was compared.

Results: Of 180 patients 107 had grade four persistent air leaks even after 4 days of underwater seal drainage, of these 20 patients were excluded as per exclusion criteria. Remaining 87 patients were divided in two comparable groups. From 2010 – 2013 patients were not receiving postoperative negative suction for PAL they were managed on under-water seal drainage only. During this period, 36 such patients were found. Their time for resolution of air leak was compared with 51 patients who had received negative suction for PAL from 2014-2019. The primary end point was the time elapsed between placement and removal of drains. All the data was analysed, and comparisons done. This was then subjected to statistical analysis and tests. No significant difference was found in the two groups. Whether the negative suction was applied or not the time to stoppage of air leak or recovery was identical.

Conclusion: In Pediatric patients undergoing decortication for empyema thorax; either VATS or Open; applying negative suction to intercostal drainage offers no additional advantage in closure of PAL or recovery.

Abbreviations: PAL: Persistent Air Leak; VATS: Video Assisted Thoracosopic Decortication; CECT: Contrast Enhanced Computed Tomography; STS: Society of Thoracic Surgeons

Introduction

Empyema thorax is a prevalent condition especially in the poor socioeconomic strata in developing countries like ours. American Thoracic society has described 3 stages of empyema. While most literature supports use of appropriate antibiotics with or without chest tube drainage for stage 1, Video assisted thoracosopic decortication (VATS) or fibrinolytics for stage 2 and open decortications for stage 3, the treatment modalities for transitions of each of these require treating doctors' decision. All of these are associated with due morbidity and longer hospital stay. After surgical treatment, PAL can add to the morbidity and needs to be addressed. Although not much literature exists on application of negative suction as a part of its management, it is well known. But its efficacy needs to be weighed against the pain, decreased mobility and cost associated with it. In this study we have done retrospective analysis of these patients and compared the number of days in which intercostal drainage tube could be removed in patients who received or did not receive a negative suction to under water seal drainage tube for PAL.

Material and Methods

This is a retrospective case control study, examining all pediatric patients admitted for empyema thorax who underwent decortications and developed PAL. This study was approved by the institutional review board at GGMC and sir JJ hospital and individual consents waived. Exclusion criteria were patients with stage 1 empyema; no air leak postoperatively; with inadequate staging or not evaluated by contrast enhanced computed tomography (CECT), immune compromised status, undergoing repeat surgery lobectomy;, for the ease of comparison and to avoid bias. Of 180 patients with stage 2 and 3 empyema; only 107 had grade four persistent air leaks even after 4 days of underwater seal drainage, of these 20 patients were excluded as per exclusion criteria.

Remaining 87 patients were divided in two comparable groups. All the patients included in study were divided in 2 groups; group 1 with stage 2 and 3 empyema had received negative suction of -10 to-20 cm of water for post-surgery air leak from 2014-2019 and had 51 patients. The control group was comparative group of stage 2 and 3 empyema who had not received negative suction for PAL from 2010-2013 consisting of 36 patients. Staging was done on basis of CECT findings. Data was obtained from the medical record section of the hospital, with patient history and investigation records with images and in hospital charts with complete pre and postoperative data available. The number of days from surgery till ICD removal after first 4 days of underwater seal drainage was compared (Figure 1) and subjected to statistical analysis.

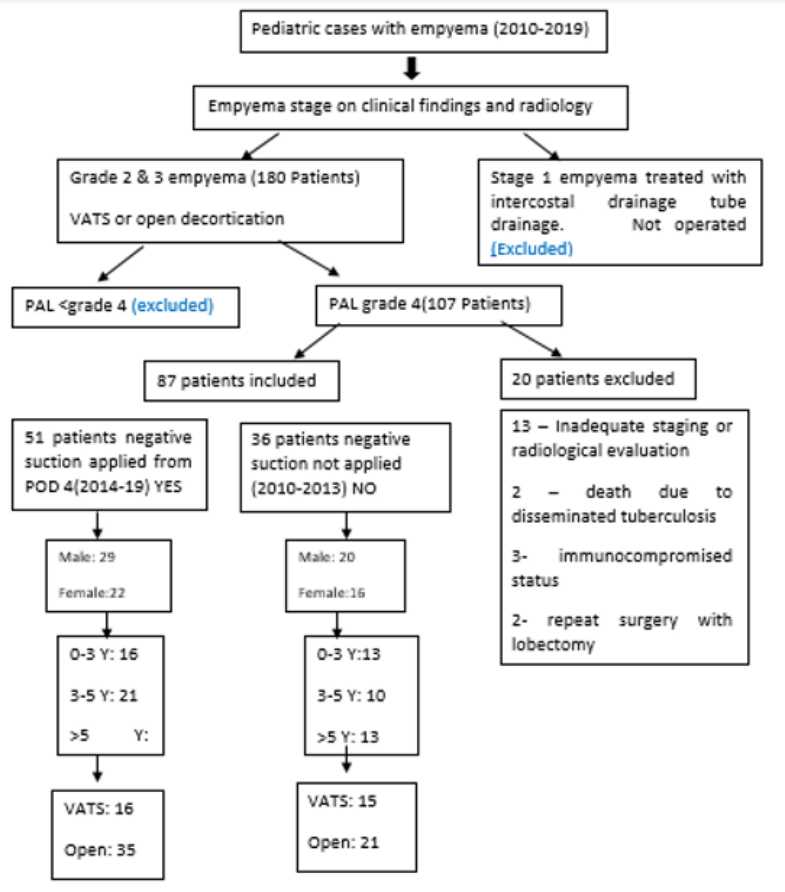

Figure 1: Demographics with inclusions and exclusions.

Results: Over 10 years 87 patients included in study with stage 2 or 3 empyema having grade 4 PAL were identified. Age of patient ranged from 3 months to 11 years (Table 1). There were 49 boys and 38 Girls (Table 2). In first group patients undergoing surgery: VATS or open decortication subjected to negative suction – 10 to -20 cm of water were compared with the second group not subjected to negative suction (Tables 3&4). Initially baseline parameters were compared (Table 5). After data collection, data entry was done in Excel. Data analysis is done with the help of SPSS Software version 15. Quantitative data is presented with the help of Mean, Standard Deviation, Median and IQR, comparison among study groups is done with Unpaired T test. Qualitative data is presented with the help of Frequency and Percentage table; association among various study parameters is assessed by Chi-Square test (Fisher Exact test for 2*2 tables). P value less than 0.05 is taken a significant level.

Table 1: Distribution of study group as per Age in Yrs.

Age in Yrs	Frequency	Percent
Upto 3 Yrs	29	33.33%
3 to 5 Yrs	31	35.63%
Above 5 Yrs	27	31.03%
Total	87	100.00%

Table 2: Distribution of study group as per sex.

Sex	Frequency	Percent
Male	49	56.32%
Female	38	43.68%
Total	87	100.00%

Table 3: Distribution of study group as per Negative suction.

Negative suction	Frequency	Percent
Yes	51	58.62%
No	36	41.38%
Total	87	100.00%

Table 4: Distribution of study group as per Sx done.

Sx done	Frequency	Percent
Open	31	35.63%
VATS	56	64.37%
Total	87	100.00%

Table 5: Comparison of baseline parameters among study group.

Study Parameter	Negative suction	N	Mean	Std. Dev	Unpaired T test	P Value
Wt (Kg)	Yes	51	13.95	5.34	-1.35	0.181
	No	36	15.74	7	Difference is not Sig	
Age In Yrs	Yes	51	4.51	2.831	-0.47	0.64
	No	36	4.83	3.531	Difference is not Sig	

This comparison was done collectively by unpaired t test and the difference was not found to be significant (Table 6). Also the comparison was done in identical groups; age wise (Tables 7&8), sex wise (Tables 9&0), as per CT grading (Table 11) and surgery wise (Tables 12&13) ; appropriate statistical analysis was done subjecting to Pearson chi square test and Fisher Exact test. In all these comparisons the difference was not found to be significant. Hence whether the negative suction was applied or not the time to stoppage of air leak or recovery was identical. Thus, from this study we infer; negative suction has no additional advantage in early closure of PAL hence recovery of patient.

Table 6: Comparison of ICD removal in days in study groups Negative suction.

Negative suction	N	Mean	Std. Dev	Unpaired T test	T Value
Yes	51	10.16	5.86	-0.232	0.817
No	36	10.47	6.759	Difference is not Sig	

Table 7: Association among study group between, Age in Yrs * Negative suction.

Age in Yrs		Negative suction		Total
		Yes	No	
Upto 3Yrs	No	16	13	29
	%	31.40%	36.10%	33.30%
3 to 5Yrs	No	21	10	31
	%	41.20%	27.80%	35.60%
3)Above 5Yrs	No	14	13	27
	%	27.50%	36.10%	31.00%
Total	Count	51	36	87
	%	100.00%	100.00%	100.00%

Pearson Chi-Square	Value	df	P Value	Association is
Pearson Chi-Square	1.715	2	0.424	Not Sig

Table 8: Comparison of Days of ICD removal among study groups.

Study Group	Negative suction	N	Mean	Std. Dev	Unpaired T test	T Value
Upto 3 Yrs	Yes	16	8.81	4.293	0.224	0.824
	No	13	8.46	4.054	Difference is not Sig	
3 to 5 Yrs	Yes	21	9.81	4.633	0.569	0.574
	No	10	8.8	4.59	Difference is not Sig	
Above 5 Yrs	Yes	14	12.21	8.414	-0.462	0.648
	No	13	13.77	9.084	Difference is not Sig	

Table 9: Association among study group between, sex * Negative suction.

sex		Negative suction		Total
		Yes	No	
Male	No	29	20	49
	%	56.90%	55.60%	56.30%
Female	No	22	16	38
	%	43.10%	44.40%	43.70%
Total	No	51	36	87
	%	100.00%	100.00%	100.00%
Total	Count	51	36	87
	%	100.00%	100.00%	100.00%

Pearson Chi-Square	Value	df	P Value	Association is
Pearson Chi-Square	0.015	1	0.904	Not Sig
Fisher's Exact Test			1	Not Sig

Table 10: Comparison of days of ICD removal among study groups.

Sex	Negative suction	N	Mean	Std. Dev	Unpaired T test	T Value
Male	Yes	29	10.07	5.824	-0.388	0.7
	No	20	10.85	8.299	Difference is not Sig	
Female	Yes	22	10.27	6.041	0.154	0.879
	No	16	10	4.351	Difference is not Sig	

Table 11: Comparison of recovery period among study group.

CT Grading	Negative suction	N	Mean	Std. Deviation	Unpaired T test	P Value
2.00	Yes	29	8.79	5.192	1.162	0.251
	No	21	7.33	2.904	Difference is not Sig	
3.00	Yes	22	11.95	6.313	-1.223	0.230
	No	15	14.87	8.167	Difference is not Sig	

Table 12: Association among study group between Sx done * Negative suction.

Sx done		Negative suction		Total
		Yes	No	
Open	No	16	15	31
	%	31.40%	41.70%	35.60%
VATS	No	35	21	56
	%	68.60%	58.30%	64.40%
Total	No	51	36	87
	%	100.00%	100.00%	100.00%

Pearson Chi-Square	Value	df	P Value	Association is
Pearson Chi-Square	0.975	1	0.323	Not Sig
Fisher's Exact Test			0.368	Not Sig

Table 13: Comparison of days of ICD removal among study groups.

Sx Done	Negative suction	N	Mean	Std. Dev	Unpaired T test	T Value
Open	Yes	16	9.88	6.386	-0.601	0.552
	No	15	11.2	5.846	Difference is not Sig	
VATS	Yes	35	10.29	5.696	0.189	0.851
	No	21	9.95	7.44	Difference is not Sig	

Discussion

The definition for the term PAL varies in multiple published studies and proposed definitions of PAL range from an air leak lasting four days to greater than ten days postoperatively [1]. Based on recent literature several authors have recommended defining a PAL as an air leak lasting beyond postoperative day 4. This definition is consistent with The Society of Thoracic Surgeons (STS) database definition for a PAL as an air leak exceeding the otherwise necessary length of stay [2]. PAL is the most prevalent postoperative complication with reported occurrence of 18-26% to higher rates 45-58% surgeries; more so after infectious conditions [2]. After decortication procedures whether video assisted or open, PAL is very prevalent and associated with significant morbidity. Some surgeons theoretically believe that suction has the advantages of favouring the apposition of parietal and visceral pleurae, promoting the sealing of air leaks [3,4]. This approach seems more reasonable, particularly after pulmonary lobectomy when a greater pleural residual space is created compared with minor resections. On the other hand, suction applied to the tubes may lead to an increase in the volume of air leaking from the parenchyma, hindering the sealing process [5]. Hence, the benefit of active suction applied to the underwater seal drainage for reduction of postoperative leaks is inconclusive. Application of active suction to underwater seals in an attempt to close these and decrease hospital stay thus needs to be evaluated along with morbidity associated with it.

In English literature multiple papers have been published addressing PAL and various options for management including application of negative suction to underwater seal drainage tube for early sealing [6]. However majority of these studies are in adults and mainly after lung resection. Yet no standardization could be

achieved in favor of or against using suction with mixed results. Very little literature approaches PAL in pediatric patients post empyema thoracis. Also, in developing countries like ours it is difficult to afford or provide hemlich valve, portable suctions and digital thoracic drainage, as most of children suffering from empyema thorax are from lower socioeconomic groups. Hence traditional underwater seal drainage is kept post procedure for all these patients at our institute. These children are observed for air leak and patients with grade four air leak, as per Cerfolio classification of air leaks [7], persistent even after 4 days after surgery are subjected to negative suction application to under-water seal.

In this study we retrospectively evaluated records of all pediatric patients undergoing decortication from 2010-2019. We found that patients treated between years 2010-2013 with PAL were managed only with underwater seal drainage till the resolution of air leak. From year 2014 to 2019 such patients were put on negative suction to drainage system at -10 to -20 cm of water to early closure of leaks and subsequently Intercostal drains removed and patients discharged. All these patients were divided in three age groups having stage 2 or 3 empyema on CT scan undergoing decortication either VATS or open accordingly. Two groups were made from these as per whether negative suction was used or not and compared, where we found no significant difference between the two. Applying negative suction to intercostal drainage for PAL increases the morbidity of children by increasing the pain, reduced mobility and adds to the cost of management without offering any additional advantage in decreasing the air leak early. On reviewing English literature, we found a few studies supporting our findings although done in adults and for PAL after lobectomy [8]. Even by a meta-analysis of all articles comparing the application of negative suction to drainage and patients managed without it, there was no significant difference between suction and non-suction on the duration of prolonged air leaks [6].

Conclusion

In Pediatric patients undergoing decortication for empyema thorax; either VATS or Open; applying negative suction to intercostal drainage offers no additional advantage in closure of PAL or recovery.

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