The comparison of vacuum assisted closure (VAC) and conventional treatment methods in postpneumonectomy empyema cases

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Abstract
Aim: Postpneumonectomy empyema is one of the most difficult clinical conditions in thoracic surgery. There is a wide range of conventional treatment options ranging from tube thoracostomy, antibiotic irrigation to open-window thoracostomy. Vacuum-Assisted Closure (VAC) therapy is also among the treatment options. In our study we aimed to compare the outcomes and efficiency of conventional treatment procedures and VAC.

Material and Methods: Eighteen male patients (average age 54.8±18.68), who were diagnosed with postpneumonectomy empyema between July 2012 and November 2014, were divided into two groups. Nine patients (Group I) have been treated with conventional procedures, while the other nine patients (Group II) have been treated with VAC.

Results: Five patients in the Group I were cured in an average of 9.6 months. Four patients underwent additional surgical intervention and they remained in the empyema clinic for 12 months in the follow-up period. Seven patients in the Group II were cured during the follow up period of an average of 14.8 months. Two patients who developed bronchopleural fistula remained in the empyema clinic. Average length of hospital stay is 109.3 days for the Group I and 63 days for the Group II. The treatment of the Group II has been found more successful than the Group I in terms of pain status assessment, patient's comfort and postoperative cosmetic appearance.

Conclusions: VAC group success rate has been found higher in terms patient's comfort, the length of hospital stay and duration of empyema. Further studies are required to establish the success of this procedure.

Keywords: Postpneumonectomy empyema; Vacuum-Assisted Closure (VAC); Thoracostomy.

INTRODUCTION
One of the major reasons of morbidity and mortality in postpneumonectomy cases is the empyema developing during the postoperative period. The conventional treatment method for empyema has been antibiotic irrigation until the cavity is sterilized, in other words, modified Clagett method, during the early period and the window thoracostomy during the late period. The modified Clagett method has been successful in the early period of the treatment of empyema and has been the preferred method for the weak patients. However, the length of hospital stay ranging between 2-425 days and high rates of complications (55%) encouraged the search for alternative treatment procedures (1). For that reason, vacuum assisted drainage and wound closure system were first applied intrathoracically by Ditterich et al. (2). Our purpose in this study is to discuss the results of the conventional treatment methods (tube thoracostomy, antibioteraphy, Clagett Method, thoracomyoplasty and open window thoracostomy etc.) and the Vacuum Assisted Closure (VAC) and to compare them in terms of their efficiencies for the treatment of the patients developing post pneumonectomy empyema or joint bronchopleural fistula.
MATERIAL and METHODS

Eighteen cases, who developed postpneumonectomy empyema with or without bronchopleural fistula, were retrospectively examined in the department of Thoracic Surgery in Atatürk Chest Disease and Chest Surgery Training and Research Hospital between July 2012 and November 2014. The study was approved by the Institutional Ethics Committee and conducted in accordance with the ethical guidelines of the Helsinki Declaration.

Between 2012 and 2014, resection was performed for a total of 603 cases, 506 of which was for lung cancer and 97 for other illnesses. The pneumonectomy was performed for 103 cases, 65 of them being left pneumonectomy and 38 right pneumonectomy. Post-pneumonectomy empyema was recorded in 6 of these cases, 4 of which had no fistula. The cases were divided into two groups as the ones who were treated with conventional treatment methods such as tube thoracostomy, antibiotherapy, Clagett Method, thoracomyoplasty and open window thoracostomy and the ones who were treated with VAC. For nine cases, conventional treatment methods were applied and for the remaining nine cases VAC treatment was applied. Those who did not accept VAC treatment were included in group 1 who underwent conservative treatment. When empyema was identified among the patients who received conventional treatment methods, first drainage with tube thoracostomy, empiric antibiotherapy and irrigation were performed. Only povidone iodine and rifampicin wash were used for the patients. Local effect of antibiotics has not been utilized. However the patients were given certain dose of antibiotics treatment as prescribed by the infectious diseases specialist according to the wound location and the results of blood cultures in the first sessions after the empirical systemic antibiotics treatment. According to the presence and size of fistula, primary closure, extrathoracic muscle transpositions (myoplasty), bronchoscopic tissue adhesives were utilized. The patients in group 1 did not have thoracomyoplasty because of refusing second operation.

In the first session, open thoracic window process under general anesthesia and wound site debridement with VAC were performed for the patients who were treated with VAC. During the next sessions, sponge change was performed applying medical dressing with conscious sedation.

V.A.C. APPLICATION TECHNIQUE: The patients were intubated using endobronchial single-lumen tube in the lateral decubitus position. With an approximate 5-cm cut, an appropriate window was opened through a partial rib resection with the help of thoracoscopy from the remaining place of the previously located chest drain. The thorax cavity was debrided through the curettes and culture specimens were taken from wound sites. The inner thorax was mechanically cleaned with Povidone Iodine or Rifampicin with saline solution. The vacuum pressure was arranged as 70-125 mm-Hg according to the patient. The appropriate antibiotherapy was started according to the culture results. The procedure was repeated together with...
Sedation in an average of 4-6 days. Sponge changes were performed under operating room conditions while the patient was awake with conscious sedation with epidural analgesia support. (Figure 1, figure 2, figure 3, figure 4) VAC was applied to one of the cases during re-thoracotomy and completion for the pneumonectomy. The VAC application was completed by filling the thorax cavity with saline solution containing iodine and rifampicin under general anesthesia together with blood congestion within the thorax cavity and formation of granulation tissue after the reduction of negative culture of the wound site and the drainage.

No statistical evaluation has been done because of the low number of cases.

RESULTS

Post-pneumonectomy empyema was recorded in 6 of these cases, 4 of which had no fistula. The other 12 cases included in our study had been referred to our clinic from other clinics for further treatment. Atatürk Chest Diseases and Chest Surgery Education and Research Hospital is a leading hospital in this field and it is the biggest center for further treatment in Turkey where complicated cases are referred. Thus, we treat complications in cases whose primary surgery was not carried out in our hospital as well as major post-surgery pathologies that could arise due to different reasons.

Eighteen cases, who were suffering from empyema with bronchopleural fistula or without bronchopleural fistula after pneumonectomy were analyzed. All of the patients were male. The average age of the patients were 54.8 (min 18-max 68) years. The patients were divided into two groups:

Group I: Patients treated with conventional methods (Table 1)

Group II: Patients received VAC treatment (Table 2)

The average age was 55.2 (min 40-max 65) years in the

### Table 1. The features of the Group I patients

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age</th>
<th>Sex</th>
<th>Smoking</th>
<th>Diabetes</th>
<th>Ellitus</th>
<th>COPD</th>
<th>CRT</th>
<th>MV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>40</td>
<td>M</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>2</td>
<td>52</td>
<td>M</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>3</td>
<td>47</td>
<td>M</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>4</td>
<td>54</td>
<td>M</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>5</td>
<td>63</td>
<td>M</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>6</td>
<td>57</td>
<td>M</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>7</td>
<td>56</td>
<td>M</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>8</td>
<td>65</td>
<td>M</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>9</td>
<td>63</td>
<td>M</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>+</td>
</tr>
</tbody>
</table>

COPD: Chronic Obstructive Pulmonary Disease, CRT: Chemoradiotherapy, MV: Mechanic Ventilation

### Table 2. The features of the patients in the Group II

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age</th>
<th>Sex</th>
<th>Smoking</th>
<th>Diabetes</th>
<th>COPD</th>
<th>CRT</th>
<th>MV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>51</td>
<td>M</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>2</td>
<td>59</td>
<td>M</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>3</td>
<td>56</td>
<td>M</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>4</td>
<td>68</td>
<td>M</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>5</td>
<td>48</td>
<td>M</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>+</td>
</tr>
<tr>
<td>6</td>
<td>18</td>
<td>M</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>7</td>
<td>50</td>
<td>M</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>8</td>
<td>60</td>
<td>M</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>9</td>
<td>68</td>
<td>M</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>–</td>
</tr>
</tbody>
</table>

COPD: Chronic Obstructive Pulmonary Disease, CRT: Chemoradiotherapy, MV: Mechanic Ventilation
Group I. Pneumonectomy was applied to all of the cases because of non-small cell lung cancer. Five squamous cell carcinoma were reported in the pathological examination. One of them was in stage Ib and the rest were in stage IIIa. They included one carcinoid tumor, two synchronous tumors (squamous and adenocarcinoma) and one adenocarcinoma (stage IIb). Adjuvant chemotherapy was applied on four cases and postoperative radiotherapy was applied on three cases. Patients in Group I did not receive neo-adjuvant chemotherapy. Mechanical Ventilation was required for two postoperative patients. (Table 3)

The average age was 53.1 (min 18-max 68) years in the Group II. Two of the patients had tuberculosis history. Pneumonectomy was performed for seven of the cases because of non-small cell lung cancer. The pneumonectomy was performed for the 18 year old patient with post tuberculosis lung destruction. The first operation was done in another clinic and referred to us. Post-lobectomy remained parenchyma was destroyed so we perform pneumonectomy.

Four of them were in stage IIIa, one of them was in stage IIb and one of them was in stage IIIb. One of the cases had tuberculosis-aspergillum, therefore upper lobectomy and myoplasty were performed because of the traumatic bronchus rupture. The case then underwent rethoracotomy, completion pneumonectomy and myoplasty. Six cases who were treated with VAC received chemotherapy and/or radiotherapy. Mechanical ventilation history was present in one preoperative case. (Table 4)

We performed primary suturing for early fistula cases and our general clinical approach is primary suturing and myoplasty. Because stapling is used for bronchial closure in recent years, we have not seen fistula case due to surgical technique.

In our study, VAC therapy was considered successful in comparison with the conventional treatment methods in terms of complication, the length of the hospital stay, follow-up without empyema and satisfaction of the patients. (Table 5) Patient satisfaction was assessed depending on the wound closure and negative results of cultures.

**DISCUSSION**

Postpneumonectomy empyema is a life threatening condition. It mostly occurs together with bronchopleural

**Table 3. The surgical procedures applied previously to the Group I patients**

<table>
<thead>
<tr>
<th>Patient</th>
<th>First Operation</th>
<th>Complication</th>
<th>2nd or 3rd Operation/Treatment</th>
<th>Post treatment Status</th>
<th>Empyema Duration</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Right</td>
<td>PPA+Fistula</td>
<td>Irrigation+ 3 times of fibrin glue application+ Myoplasty</td>
<td>Absent</td>
<td>15 months</td>
<td>Accomplished</td>
</tr>
<tr>
<td>2</td>
<td>Right</td>
<td>PPA+Fistula</td>
<td>2 times Myoplasty</td>
<td>Empyema</td>
<td>25 months</td>
<td>Failure</td>
</tr>
<tr>
<td>3</td>
<td>Upper right lobectomy + chest wall resection</td>
<td>Perfusion and expansion defect in residual lung+ Empyema</td>
<td>Re- thoracotomy + Completing to pneumonectomy and opening thoracostomy</td>
<td>Fistula+, Empyema</td>
<td>7 months</td>
<td>Failure</td>
</tr>
<tr>
<td>4</td>
<td>Right</td>
<td>Empyema+Fistula</td>
<td>Clagett Method+ Endobronchial stent application</td>
<td>Absent</td>
<td>6 months</td>
<td>Accomplished</td>
</tr>
<tr>
<td>5</td>
<td>Right</td>
<td>Empyema+Fistula</td>
<td>Clagett Method+ Myoplasty</td>
<td>Recurrent tumor (superior vena cava syndrome)+ Fistula</td>
<td>15 months</td>
<td>Failure</td>
</tr>
<tr>
<td>6</td>
<td>Right</td>
<td>Post chemotherapy+ empyema</td>
<td>Clagett Method+ Myoplasty</td>
<td>Absent</td>
<td>4 months</td>
<td>Accomplished</td>
</tr>
<tr>
<td>7</td>
<td>Right</td>
<td>Eusophageal Fistula</td>
<td>Clagett Method+ Myoplasty+ Eusohageal Stent Myoplasty</td>
<td>Absent</td>
<td>13 months</td>
<td>Accomplished</td>
</tr>
<tr>
<td>8</td>
<td>Right</td>
<td>Fistula</td>
<td>Clagett Method+ Myoplasty+ Eusohageal Stent Myoplasty</td>
<td>Empyema+ Mechanic Ventilation</td>
<td>1 months</td>
<td>Failure</td>
</tr>
<tr>
<td>9</td>
<td>Right Sleeve</td>
<td>Fistula+ Empyema</td>
<td>Myoplasty</td>
<td>Absent</td>
<td>10 months</td>
<td>Accomplished</td>
</tr>
</tbody>
</table>

PPA: Postpneumonectomy Empyema
fistula making its treatment difficult. Among all surgical
resections, the rate of BPF development varies between
0.3-11% and is most commonly seen after right
pneumonectomy. The incidence of fistula increases in
surgical procedures performed in infectious diseases
such as tuberculosis. The specified mortality rates are
30-70%, and early diagnosis and appropriate surgery are
essential (3). Clagett method is a successful method in
treating early period empyema. However the variation in
average length of hospital stay between 2-425 days and
high levels of complication rates (55%) has encouraged the
search for alternative procedures (1). Similarly, although
open window thoracostomy seems to be an appropriate
treatment option for the chronic empyema cases and for
the patients who are not appropriate for further surgical
procedures, it has got major disadvantages including the
long treatment durations such as 2-7 months and its being
an uncomfortable method because of the requirement for
daily povidone iodine (4). In our study, most of the patient’s
primer pathology is non-small lung cancer and it is still
frequent in males in our country. The average length of
hospital stay was 109.3 (12-204) days in the Group I and
the surgical procedures that were performed were more
than one. In five patients, the empyema could be cured
at the end of 9.6 months in average (4-15). Empyema
continued during the mentioned period in four patients.
Permanent vacuum proves to be more effective for wound
site cleaning in comparison to the conventional methods.

VAC therapy has proven more influential compared to
the conventional treatment methods in postoperative
empyema (5). In a study with 19 cases of empyema series
by Palmen, eight cases received daily medical dressing
for open window thoracostomy, 11 cases were treated
with VAC following open window thoracostomy and these
cases were cured in 39±17 and 31±19 days, respectively.
The average length of hospital stay for VAC applied
patients was found as 55 days, and for the ones VAC
was not applied was 101 days. All of the patients were
followed up for 46±19 months in average (6). Al Muffarej
et al searched six cases of empyema series (two of them
were PPA and four had other empyema) through the VAC
method (8). In the mentioned series, one of the cases of
PPA was identified with pseudomonas reproduction, but
the other case was not identified with any microorganism.
In the cases, sterilization in thorax was provided at the
end of 53 days in average (40 and 63). Matzi et al reported
pseudomonas reproduction in culture of a 20 year-old
case with PPA and who was cured through VAC, and
sterilization in thorax was fulfilled after 46 days (5). In our
study, five of the cases in Group II were pseudomonas,
there was polymicrobial reproduction in two cases, MRSA
in one case and pleural fluid microorganism in one case.
The tissue cultures did not contain microorganisms. The
thorax sterilization of the patients in this group took 63
days in average (25-148). The mean sponge change
per capita was found as 5.4 times while Aru et al found

<table>
<thead>
<tr>
<th>Patient</th>
<th>First Operation</th>
<th>Complication</th>
<th>Second Operation/ Treatment</th>
<th>Post Treatment Status</th>
<th>Empyema Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Left</td>
<td>PPA (without fistula)</td>
<td>Clagett Method</td>
<td>Empyema</td>
<td>18 months</td>
</tr>
<tr>
<td>2</td>
<td>Right</td>
<td>PPA (without fistula) + Chest wall necrosis in related to RT</td>
<td>Chest wall Resection + Myoplasty</td>
<td>Empyema</td>
<td>3 months</td>
</tr>
<tr>
<td>3</td>
<td>Left</td>
<td>PPA (without fistula)</td>
<td>Clagett Method</td>
<td>Empyema + Without Fistula</td>
<td>13 months</td>
</tr>
<tr>
<td>4</td>
<td>Right</td>
<td>PPA + BPF</td>
<td>Closure of fistula + Myoplasty</td>
<td>Empyema + Without Fistula</td>
<td>12 months</td>
</tr>
<tr>
<td>5</td>
<td>Right</td>
<td>PPA + BPF</td>
<td>Closure of fistula + Myoplasty</td>
<td>Micro Fistula + Empyema</td>
<td>10 months</td>
</tr>
<tr>
<td>6</td>
<td>Upper right lobectomy + myoplasty</td>
<td>BPF + Empyema</td>
<td>Completed Pneumonectomy + Myoplasty</td>
<td>Micro Fistula + Empyema</td>
<td>4 months</td>
</tr>
<tr>
<td>7</td>
<td>Right</td>
<td>Closure of fistula + Myoplasty</td>
<td>Clagett Method</td>
<td>Empyema + Fistula + Empyema</td>
<td>7 months</td>
</tr>
<tr>
<td>8</td>
<td>Right</td>
<td>PPA (without fistula)</td>
<td>Closure of fistula + Myoplasty</td>
<td>Empyema + Empyema</td>
<td>2.5 months</td>
</tr>
<tr>
<td>9</td>
<td>Right</td>
<td>PPA + BPF</td>
<td>Closure of fistula + Myoplasty</td>
<td>Empyema + Empyema</td>
<td>2.5 months</td>
</tr>
</tbody>
</table>

BPF: Bronchopleural Fistula

<table>
<thead>
<tr>
<th>Groups (n9)</th>
<th>Length of Hospital Stay (Day)</th>
<th>Postoperative Follow-up Period (month)</th>
<th>Complication (pain) (n)</th>
<th>Follow-up without empyema (n)</th>
<th>Patient’s satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>109.2</td>
<td>9.5</td>
<td>8</td>
<td>5</td>
<td>Bad</td>
</tr>
<tr>
<td>Group 2</td>
<td>63</td>
<td>14.8</td>
<td>2</td>
<td>7</td>
<td>Good</td>
</tr>
</tbody>
</table>

Table 4. Previously applied procedures in the Group II

Table 5. Comparison of the groups
Al Mufarej et al found it as 5.2 (8). Saadi et al reported that culture results are not important whether they are negative or positive only after the healthy granulation tissue develops (9). Closure of the residue space with Clagett method is sufficient after the cavity heals with sufficient granulation tissue, before the thoracostomy closure. Yet, in terms of cosmetics and its being less invasive, it seems to be a better option in comparison with the other cavity filling methods. For this reason, we preferred closure by modified Clagett method in the cases for who VAC was applied.

CONCLUSIONS

VAC treatment method has been found visible and reasonably better compared to classical treatment methods in the cases of postpneumonectomy empyema cases, which are among the difficult clinical entities in terms of treatment and follow up in the thoracic surgery clinics.

As all thoracic surgeons agree, treatment process in postpneumonectomy empyema cases is long and difficult for the patient. In our study, we found that the length of hospital stay for the patients in the VAC group has shortened, empyema duration decreased and life quality of the patients proportionally increased. VAC treatment which is not difficult in terms of application and follow-up can be successfully applied in appropriate patients.

Competing interests: The authors declare that they have no competing interest.

Financial Disclosure: There are no financial supports

Ethical approval Ethics committee approval was received from Karatay University Faculty of Medicine. 2019/0036

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