Gadjah Mada Vacuum Assisted Closure as an alternative cost effective therapy in soft tissue defect

Meirizal, Bagus Yudha Pratama, Rahadyan Magetsari

ABSTRACT

Aims: The speed of wound healing process depends on many factors. One way to speed up the wound healing process is with the use of Vacuum Assisted Closure (VAC). VAC is a system that can provide negative pressure on the wound. But VAC nowadays still not a cost-effective therapy to be applied in Indonesia. To solve this, we developed a device that has a system just like VAC but with a lower cost, Gadjah Mada (Gama) VAC. Materials and Methods: This study illustrate the process of wound healing in traumatized patients with skin defects using Gama VAC. Ten patients included in this study, 8 males and 2 females. Parameters that measured in this research are Hospital Length of Stay (LOS) and growth time of granulation tissue with the use of Gama VAC. Results: This study showed that the average LOS in patients with Gama VAC is 23, 3 days. And the growth time of granulation tissue in patients with Gama VAC is 22 days. Conclusion: VAC is one of the alternative therapy on soft tissue defect. Gama VAC is a more cost-effective device with the same mechanism and advantages as those of other VAC device.

Keywords: Gadjah Mada Vacuum assisted closure, Soft tissue defect

INTRODUCTION

Wound healing is a complex biological process that will eventually restore tissue integrity. The speed of the healing process depend on many factors, one of them is the width of the wound [1, 2]. One way to speed up the wound healing process is with the use of Vacuum Assisted Closure (VAC). VAC is a system that can provide negative pressure on the wound. But VAC nowadays still not a cost-effective therapy to be applied in Indonesia. The cost of the VAC device is the main factor. To solve this, we developed a device that has a system just like VAC but with a lower cost, Gadjah Mada (Gama) VAC.

This VAC system consists of 4 main components, which are: (1) sponge material placed above the wound; (2) a semipermeable dressing to cover the wound from the external environment and to transmit negative pressure to the surface of the wound; (3) connecting hoses; and (4) negative pressure-generating machine [3].

There are four mechanisms of the VAC system in promoting soft tissue healing (Figure 1), which are: (1) contracting the wound (macrodeformation); (2) stabilize the wound environment; (3) removing extracellular fluid; and (4) microdeformation [3].

Gama VAC (Figure 2) is a VAC device developed by Orthopedic and Traumatology Division of Dr. Sardjito and Physics Laboratorium of Gadjah Mada University. This machine has a negative pressure adjusted to the...
ideal VAC pressure, and also for other materials such
as the foam (special foam that has been sterilized), the
semipermeable adhesive, and the canister (glass bottle).

MATERIAL AND METHODS

This study illustrate the process of wound healing in
traumatized patients with skin defects using Gama VAC
(Figure 1). Parameters that measured in this research
are Hospital Length of Stay (LOS) and growth time of
granulation tissue with the use of Gama VAC.

The production process of GAMA VAC begins with
preparing for the tools and materials to be used (Figure
2) which consist of:

1. Aerator Pump Revou DC-111
   This aerator engine was taken from a tank aerator
   engine which was later modified by changing the
direction of the fan from the original function
of producing the air becomes a machine that
can remove the air. Thus, when this machine is
applied to a closed space, it can produce negative
pressure.
2. Gama VAC Frame
3. Hoses
4. Pressure Regulator
5. Pressure Gauge
6. Power cable
7. Hose Connector
8. Glue
9. Switch
10. Electric coil
11. Magnet

After the material tool had been obtained, the first
thing to do was to make a GAMA VAC box frame. This
box was made of stainless steel in the form of sheets and
then formed into beams using welds. The next step was
to assemble an aerator machine that is used as a suction
device. We used 3 aerator which were then arranged
into 1 to have the desired suction force. This aerator
engine was then attach to the coil. The coil on GAMA
VAC act as a converter from electric power into magnetic
power which then moves the aerator engine so that it
can produce a negative pressure. After the main engine
circuit had been finished, the hose was then attached to
the aerator and then a gauge and pressure regulator were
also attached. The last step was to assemble the power
and switch systems in Gama VAC. GAMA VAC has a
negative pressure power range between 100 mmHg - 150
mmHg. This pressure is the ideal pressure to accelerate
wound healing in a VAC system.

This model of VAC is developed by Meirizal, MD who
is an orthopaedic surgeon in Sardjito General Hospital.

The study was conducted from January 2018 to April
2018. The data were taken in the form of secondary
data, i.e. all cases of soft tissue defects treated by Gama
VAC during 2017. The overall tie contained 10 patients
consisting of 8 males and 2 females. The location of soft
tissue defects varies, may occur in the upper limb or lower
extremity of the patient. Data were collected by collecting
pre-VAC, pre-definitive procedure, and post definitive
procedure clinical photographs.

The outcome of the study was defined by calculating
Length Of Stay (LOS) and granulation time. LOS in the
hospital was calculated according to the number of days
the patient was treated from the time of admission in the
ER until the patient was discharged. While the growth
time of granulation tissue was calculated since the first
time the patient used VAC therapy until the definitive
closure procedure, either with STSG or flap.

RESULTS

This study involved 10 patients, which consisted of 8
men (80%) and 2 women (20%). The average age is 35.4
years.
From the results of the study, the average LOS of the patient's with VAC treatment is 23.3 days and the average growth rate of granulation tissue is 22 days. The shortest LOS is 3 days and the longest is 44 days. As for the growth time of granulation tissue, the shortest was 7 days and the longest was 60 days (Table 1).

The progress of the wound can be seen in the picture below (Figure 3–6).

**DISCUSSION**

The length of stay and granulation time is varied in every patient depending on the size of the wound, general condition of the patient, presence of infection, compliance of the patients, and the skill of the practitioner in making a vacuum dressing.

Factors that affecting the wound healing can be divided into local factors and systemic factors.

**Local factors**

**Oxygenation**

Oxygen is the main component in cell metabolism, especially energy production by means of ATP, and this energy is critically important for wound healing processes. It prevents wounds from infection, induces angiogenesis, increases keratinocyte differentiation, migration, and re-epithelialization, enhances fibroblast proliferation and collagen synthesis, and promotes wound contraction. Systemic condition that might compromise tissue oxygenation will also delayed the wound healing process [4].

**Infection**

Inflammation is a normal part of the wound-healing process. In the chemical process of this phase, there would be decontamination of micro-organism in the wound. In the absence of effective decontamination, however, inflammation may be prolonged, since
microbial clearance is incomplete. This could lead into a prolonged inflammation phase, and if this continues, the wound may enter a chronic state and fail to heal [4].

**Systemic factors**

**Age**

Increased age is a major risk factor for impaired wound healing. Many study showed that aging is related to the changes in wound physiology which lead to the delayed in wound healing. This process is believed to be associated with an altered response in all wound healing phase [4].

**Stress**

Stress can cause a substantial delay in wound healing. Stress reduces the levels of the proinflammatory cytokines, this will lead to uneffective inflammation response. Stress will also impaired the immune system, and will further delayed the wound healing process [4].

**Diabetes**

The impaired healing in persons with diabetes involves multiple complex pathophysiological mechanisms, mainly the state of hypoxia and hyperglycaemia [4].

**Obesitas**

The impaired wound healing may be a result of a relative hypoperfusion and ischemia that occurs in subcutaneous adipose tissue [4].

**Medications**

Many medications, such as those which interfere with clot formation or platelet function, or inflammatory responses and cell proliferation have the capacity to affect wound healing, those medication including glucocorticoid steroids, non-steroidal antiinflammatory drugs, and chemotherapeutic drugs [4].

**Alcohol consumption**

Clinical evidences have shown that exposure to alcohol impairs wound healing and increases the incidence of infection. Alcohol exposure diminishes host resistance, and ethanol intoxication at the time of injury is a risk factor for increased susceptibility to infection in the wound [4].

**Smoking**

It is well-known that smoking increases the risk of heart and vascular disease, stroke, chronic lung
Disease, and many kinds of cancers. Nicotine stimulates sympathetic nervous activity which will cause peripheral vasoconstriction and decreased tissue blood perfusion. This condition would lead to poor oxygenation of the injured tissue and in the end would delay the wound-healing process [4].

**Nutrition**

Malnutrition or specific nutrient deficiencies can have a profound impact on wound healing after trauma and surgery. Energy, carbohydrate, protein, fat, vitamin, and mineral metabolism all can affect the healing process [4].

When compared to those who are treated with conventional wound dressing, Sinha et al. study showed that VAC therapy was significantly better in decreasing the wound size and bacterial growth [5]. Ashraf et al. who study the use of VAC in musculoskeletal injury showed that most patients with VAC therapy had hospital LOS range from 21-29 days [6]. In this study, the average LOS in patient with Gama VAC therapy was 22 days. Manish Raj et al. who evaluate the use of VAC therapy for soft tissue injury in open musculoskeletal trauma showed that the average duration of VAC therapy before definitive closure was done was 20.4 days [7]. In this study, the average duration of Gama VAC therapy before definitive closure was 22.8 days. From this result, we can conclude that the effectiveness Gama VAC therapy is comparable to those of other commercial VAC therapy.

The superiority of Gama VAC over other VAC devices is the relatively affordable device and dressing materials (Figure 7). Comparison of prices of some VAC machines in Indonesia can be seen in the following table (Table 2). Treatment cost is the cost needed for the patients to replace their vacuum dressing every 3-4 days, depending on the condition of the wound. In this case the wound is considered to have a length of 10 cm and width of 2 cm. We also provide the detail information of the unit cost (Table 3) and material cost of Gama VAC (Table 4).

While having all the advantages above, Gama VAC also has its weakness. The problem is primarily because of its complex application. For those who are not familiar with this device may find difficulties in applying to the patient, specifically when applying the foam, the hoses and the semipermeable dressing.

### Table 1: Granulation time dan length of stay of the Patients with Gama Vacuum Assisted Closure Therapy

<table>
<thead>
<tr>
<th>No</th>
<th>Name</th>
<th>Admission</th>
<th>Discharge</th>
<th>Length of stay (days)</th>
<th>Granulation time (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mr. K</td>
<td>25/09/2017</td>
<td>14/10/2017</td>
<td>20</td>
<td>23</td>
</tr>
<tr>
<td>2</td>
<td>Ms. DL</td>
<td>22/07/2017</td>
<td>08/08/2017</td>
<td>16</td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>Mr. B</td>
<td>04/02/2017</td>
<td>07/02/2017</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>4</td>
<td>Mr. DY</td>
<td>15/10/2017</td>
<td>28/11/2017</td>
<td>44</td>
<td>41</td>
</tr>
<tr>
<td>5</td>
<td>Mr. A</td>
<td>06/12/2017</td>
<td>23/12/2017</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>6</td>
<td>Mr. R</td>
<td>19/12/2017</td>
<td>07/01/2018</td>
<td>19</td>
<td>60</td>
</tr>
<tr>
<td>7</td>
<td>Mrs. T</td>
<td>11/05/2016</td>
<td>23/06/2016</td>
<td>42</td>
<td>13</td>
</tr>
<tr>
<td>8</td>
<td>Mr. S</td>
<td>26/07/2017</td>
<td>14/08/2017</td>
<td>18</td>
<td>7</td>
</tr>
<tr>
<td>9</td>
<td>Mr. FD</td>
<td>02/03/2017</td>
<td>27/03/2017</td>
<td>25</td>
<td>10</td>
</tr>
<tr>
<td>10</td>
<td>Mr. AS</td>
<td>07/02/2017</td>
<td>23/02/2017</td>
<td>16</td>
<td>11</td>
</tr>
</tbody>
</table>

### Table 2: Comparison of Treatment Cost of Vacuum Assisted Closure Devices

<table>
<thead>
<tr>
<th>No</th>
<th>Device</th>
<th>Device Price (IDR)</th>
<th>Treatment Cost (IDR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Daewoong CuraVAC®</td>
<td>61.000.000</td>
<td>1.248.000</td>
</tr>
<tr>
<td>2</td>
<td>Kalbe PICO®</td>
<td>5.775.000</td>
<td>5.775.000 (1 Package to be used up to 7 days)</td>
</tr>
<tr>
<td></td>
<td>(1 Package to be used up to 7 days)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Kalbe Renasys®</td>
<td>48.000.000</td>
<td>2.000.000</td>
</tr>
<tr>
<td>4</td>
<td>Gama VAC</td>
<td>700.000</td>
<td>237.000</td>
</tr>
</tbody>
</table>

IDR: Indonesian Rupiah
CONCLUSION

Gama VAC is one of the alternative therapy on soft tissue defect. Gama VAC is a more cost-effective device with the same mechanism and advantages as those of other VAC device.

REFERENCES


Author Contributions
Meirizal – Substantial contributions to conception and design, Acquisition of data, Analysis and interpretation of data, Drafting the article, Final approval of the version to be published
Bagus Yudha Pratama – Substantial contributions to conception and design, Acquisition of data, Analysis and interpretation of data, Drafting the article, Final approval of the version to be published
Rahadyan Magetsari – Substantial contributions to conception and design, Acquisition of data, Analysis and interpretation of data, Revising it critically for important intellectual content, Final approval of the version to be published

Guarantor of Submission
The corresponding author is the guarantor of submission.

Source of Support
None.

Consent Statement
Written informed consent was obtained from the patient for publication of this study.

Conflict of Interest
Authors declare no conflict of interest.

Data Availability
All relevant data are within the paper and its Supporting Information files.

Copyright
© 2019 Meirizal et al. This article is distributed under the terms of Creative Commons Attribution License which permits unrestricted use, distribution and reproduction in any medium provided the original author(s) and original publisher are properly credited. Please see the copyright policy on the journal website for more information.
Submit your manuscripts at
www.edoriumjournals.com