Vascular Endothelial Growth Factor Levels Difference among Hepatocellular Cancer Patients Based on Barcelona Clinic Liver Cancer Staging

Darmadi Darmadi1*, Riska Habriel Ruslie2, Cennikon Pakpahan3

1Department of Internal Medicine, Faculty of Medicine, Universitas Sumatera Utara, Medan, Indonesia; 2Department of Child Health, Faculty of Medicine, Universitas Prima Indonesia, Medan, Indonesia; 3Department of Biomedical Sciences, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia

Abstract

BACKGROUND: Hepatocellular carcinoma (HCC) is one of the most common cancers worldwide. It depends on angiogenesis for growth and metastasis. Vascular endothelial growth factor (VEGF), a growth factor for angiogenesis, is hoped to be a biomarker for the diagnosis of HCC and its development.

AIM: The objective of the study is to determine the difference of VEGF levels among HCC patients based on barcelona clinic liver cancer (BCLC) staging.

METHODS: A cross-sectional study was conducted at Haji Adam Malik General Hospital Medan, Indonesia between January and December 2018. Patients aged 18 years or older with HCC were enrolled using consecutive sampling method. Patients with cholangiocarcinoma, hemangioma, and liver metastasis were excluded from the study. The diagnosis of HCC was confirmed by triphasic computed tomography-scanning. Circulating VEGF levels were determined from serum specimen using Quantikine Human VEGF-enzyme-linked immunosorbent assay. All patients were grouped based on BCLC staging. Kruskal Wallis-H test was applied at 95% confidence interval. p < 0.05 was considered significant.

RESULTS: Of 60 patients, 47 (78.3%) were male. Mean age of patients was 61.4 (SD11.7) years. Hepatitis B was the most common etiology (70.0%) of HCC. Based on BCLC staging, 25 (41.7%) patients were in stage C. Median VEGF level was 951.25 pg/mL. There was a statistically significant difference in VEGF levels (p = 0.006) where patients in Stage C (1,009.6 pg/mL) and D (1,189.7 pg/mL) had higher VEGF levels compared to those in Stage A (578 pg/mL).

CONCLUSION: There was a statistically significant difference of VEGF levels among HCC patients based on BCLC staging.

Introduction

Hepatocellular carcinoma (HCC) is one of the most common cancers worldwide [1], [2]. Approximately there were 400 million cases of HCC globally. In the USA, the incidence of HCC increases sharply in the past 2 decades [3]. In Haji Adam Malik General Hospital Medan, Indonesia from 2009 to 2012, there were 153 patients with HCC. Patients were dominated by male gender and middle to advanced age. The reported mortality rate was 15% [4]. It carries high mortality rate, mainly due to lack of awareness for early screening. This is caused by asymptomatic feature of early-stage HCC. As the result, most patients come with advanced disease and poor survival rate [5], [6], [7]. In the other hand, despite specific treatment application, HCC’s overall survival is not satisfactory because of relapse and metastasis after treatment [2], [8].

There are several methods in classifying the severity of HCC. Among them, barcelona clinic liver cancer (BCLC) staging remains to be preferred because it can predict the outcome and assist in deciding treatment option [9]. Recently, serum biomarker such as alpha-fetoprotein (AFP) is used to detect HCC at early stages in order to deliver prompt management [10]. Elevated AFP is suspected from differentiating hepatocyte in HCC [3]. However, serum AFP alone is not an adequate tool, particularly for small HCC [11], [12].

As we know that angiogenesis plays important role in cancer growth and metastasis [8], [13]. Increased metabolism and proliferation rate in cancer cells need higher demand of oxygen and other substrates which can be obtained from circulation. The larger the cancer size, the farther the distance between cells and supplying blood vessels. At this point, angiogenesis becomes extremely important for cancer’s survival [2]. Numerous growth factors are involved in angiogenesis, one of them is the vascular endothelial growth factor (VEGF). VEGF contributes in cancer proliferation, survival, and migration by inducing mitogenesis and chemotaxis of endothelial cells and increasing vascular...
permeability [2], [7]. Liver tumors have abundant blood vessels, therefore, VEGF gives major impact toward their growth [2], [7], [12]. Earlier diagnosis will give better outcome in patients with HCC. Early diagnosis must be confirmed with rapid and accurate examination. Our study aimed to determine the difference of VEGF levels among HCC patients based on BCLC staging in hope to assist more accurate diagnosis and prudent management.

Methods

A cross-sectional study was conducted to determine the difference in VEGF levels among patients with HCC based on BCLC staging at Haji Adam Malik General Hospital Medan, Indonesia between January and December 2018. Patients aged 18 years or older with HCC were enrolled. Selection was made using consecutive sampling method. Patients with cholangiocarcinoma, hemangioma, and liver metastasis were excluded from the study. The diagnosis of HCC was confirmed by triphasic computed tomography-scanning (arterial hypervascularity followed by venous and/or delayed phase “washout”) [15]. Circulating VEGF levels were determined from serum specimen using Quantikine Human VEGF-enzyme-linked immunosorbent assay (Quantikine R and D Systems Inc., Minneapolis). In addition, other baseline characteristics of patients such as sex, age, and the etiology of HCC were gathered. All patients were grouped based on BCLC staging. Data analysis was done with statistical software and the result will be presented in tables and figures. Kruskal Wallis-H test was used to determine the difference in VEGF levels based on BCLC staging. Statistical calculation was done at 95% confidence interval and \( p < 0.05 \) was considered significant.

Results

A total of 60 patients were included in this study. Of all patients, 47 (78.3%) were male. Mean age of patients was 61.4 (SD 11.7) years. Hepatitis B was the most common etiology (70.0%) of HCC in this study. Based on BCLC staging, 25 (41.7%) patients were in Stage C, while 21 (35.0%) patients were in Stage B. We found a median VEGF level in this study of 951.25 pg/mL with minimum and maximum value of 396.0 pg/mL and 2,561.4 pg/mL, respectively (Table 1).

Table 1: Baseline characteristics of patients

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>n = 60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex, n (%)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>47 (78.3)</td>
</tr>
<tr>
<td>Female</td>
<td>13 (21.7)</td>
</tr>
<tr>
<td>Mean age, years (SD)</td>
<td>61.4 (11.7)</td>
</tr>
<tr>
<td>Etiology, n (%)</td>
<td></td>
</tr>
<tr>
<td>Hepatitis B</td>
<td>42 (70.0)</td>
</tr>
<tr>
<td>Hepatitis C</td>
<td>5 (8.3)</td>
</tr>
<tr>
<td>Others</td>
<td>13 (21.7)</td>
</tr>
<tr>
<td>BCLC stages, n (%)</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>5 (8.3)</td>
</tr>
<tr>
<td>B</td>
<td>21 (35.0)</td>
</tr>
<tr>
<td>C</td>
<td>25 (41.7)</td>
</tr>
<tr>
<td>D</td>
<td>9 (15.0)</td>
</tr>
</tbody>
</table>

Median VEGF level, pg/mL (min-max)

951.25 (396.0–2,561.4)

Table 2: VEGF levels difference based on BCLC staging

<table>
<thead>
<tr>
<th>BCLC Stages</th>
<th>Median VEGF levels (pg/mL)</th>
<th>( p^* )</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCLC A</td>
<td>578 (396–843)</td>
<td>0.006</td>
</tr>
<tr>
<td>BCLC B</td>
<td>875 (467–1,921)</td>
<td></td>
</tr>
<tr>
<td>BCLC C</td>
<td>1,009.6 (544.6–2,561.4)</td>
<td></td>
</tr>
<tr>
<td>BCLC D</td>
<td>1,189.7 (622.9–2,456.6)</td>
<td></td>
</tr>
</tbody>
</table>

*Kruskal Wallis H-test, \( * \) significant compared to stage A. VEGF: Vascular endothelial growth factor, BCLC: Barcelona clinic liver cancer.

Discussion

Liver cancer is the fifth most common cancer worldwide and the second leading cause of death from cancer [2], [8]. This cancer affects males more often compared to females with a ratio of 2–3–1 [3], [15], [16]. Most patients with HCC aged 60 years or older [12], [17]. Several risk factors for HCC are hepatitis viral infection, genetic mutations, oxidative stress, and alteration of microenvironment [2], [12], [18]. In this there was a statistically significant difference in VEGF levels (\( p = 0.006 \)) where patients in stage C and D had higher VEGF levels compared to those in stage A (1,009.6 pg/mL versus 578 pg/mL and 1,189.7 pg/mL versus 578 pg/mL, respectively). VEGF level in stage B patients (875 pg/mL) was higher than Stage A patients but the difference was not significant.

Figure 1: Boxplot diagram of vascular endothelial growth factor levels based on barcelona clinic liver cancer staging in patients with hepatocellular carcinoma
study, 78.3% of patients was male with male-to-female ratio of 3.6–1. Mean age of patients in our study was 61.4 (SD11.7) years. Hepatitis viral infection was found in 47 (78.3%) patients. Overall, baseline characteristics of patients in this study were similar to previous literatures.

Patients with HCC were classified according to BCLC staging into early-stage HCC (stage A), intermediate stage HCC (stage B), advanced stage (stage C), and terminal stage (stage D) based on tumor extension, liver functional reserve, physical status, and cancer-related symptoms [19], [20]. Patients in this study were classified according to BCLC staging. Most patients were in Stage C, followed by Stage B, Stage D, and Stage A. It can be inferred that most patients in this study were diagnosed in intermediate to the terminal stage of HCC. Delayed diagnosis could increase the risk of treatment failure and resulted in poor outcome.

Judah Folkman stated that all tumors are angiogenesis-dependent. Therefore, disrupting blood supply will kill the tumor [13]. VEGF is one of the growth factors for angiogenesis. VEGF specifically binds to VEGF receptor tyrosine kinase in endothelial cells to initiate the pathway of intracellular signal transduction that mediates angiogenesis and vascular permeability [21]. A study by Zhang et al. showed that knockdown of VEGF caused attenuation of migration, invasion, adhesion, and survival of HCC. These effects were mediated by increased expression of p53 as a tumor suppressor gene [13]. VEGF expression was increased in subjects with HCC compared to those with dysplastic nodule. VEGF had sensitivity and specificity of 68.7% and 31.2%, respectively, in diagnosing HCC [18]. Mukozu et al. reported that serum VEGF level was higher in patients with HCC compared to controls. Serum VEGF level was also higher in advanced HCC compared to liver cirrhosis and early HCC. There was no difference in serum VEGF level among HCC patients based on Child-Pugh classification. With a value of 108 pg/mL as the cut-off, serum VEGF had a sensitivity of 98% and specificity of 46% in detecting HCC [12]. This study also found that serum VEGF had a sensitivity of 78% and specificity of 84.7% in diagnosing HCC with a cut-off value of 225.14 pg/mL [7].

Li et al. found that elevated CD105 level was associated with higher VEGF level. This condition caused HCC to develop more aggressively and cause worse outcome [2]. Other biomarker was found to be associated with prognosis of HCC. The biomarker was angiogenic factor with G-patch and FHA domains 1 (AGGF1). AGGF1 was significantly higher in HCC tissue compared to surrounding normal tissue. In fact, AGGF1 was positively correlated with tissue VEGF expression [22]. A study by Yang et al. showed that endoplasmic reticulum resident oxidase 1α (ERO1α) was associated with the development and outcome of HCC. Further, ERO1α had positive correlation with VEGF-A, thus associated with angiogenesis [8]. Those studies confirmed our finding that VEGF plays the main role in HCC growth and metastasis. Past studies were in association with the result of our study. We found that VEGF level was associated with the development and metastasis of HCC. It was proved by statistical analysis results which showed a significant difference in VEGF level among patients with HCC based on BCLC staging (p = 0.006).

Without treatment, death will occur in 6–7 months after initial symptom of HCC. Survival can be prolonged up to 11–12 months with proper treatments. The outcome is also influenced by comorbidities and the nature of disease. Therefore, early detection of tumor is important in HCC management [3]. Treatment options for HCC are resection and transplantation, local tumor ablation, and chemoembolization [2], [13], [18]. Chemotherapy is one of the treatment options since liver transplantation is limited [3], [17]. After receiving chemotherapy, HCC levels decreased significantly regardless of the nature of disease. Again, they confirmed that VEGF level was useful in predicting tumor growth and invasion in HCC [17]. Another study reported that poorer outcome was associated with a higher level of serum VEGF [7]. Serum VEGF level was also useful in predicting outcome of patients with HCC after liver transplantation. Patient with higher serum VEGF level had a 12 times higher risk for having recurrence compared to those with low serum VEGF levels [23]. In this study, the higher level of VEGF will increase the stage of HCC. Patients with Stage D had the highest VEGF level, followed by patients in Stage C. The difference of VEGF levels between Stage D and C with Stage A patients was significant.

Our study had several limitations. We did not analyze comorbidities which might be present with HCC and influence the VEGF level. Finally, we did not analyze the accuracy of VEGF level in diagnosing HCC because of the absence of control group. Further study involving more patients and several centers is mandatory to confirm our result. As conclusion, there was a statistically significant difference in VEGF levels among HCC patients based on BCLC staging.

References


PMid:24083767


PMid:25922775


PMid:24922356


PMid:25796501


PMid:25756616


PMid:30022853


PMid:29576865


PMid:23482775


PMid:22161247


PMid:30235766


PMid:28978103


PMid:30687780


PMid:25862879


PMid:27556821


PMid:25848467


PMid:10930302


PMid:25796501


PMid:30235766