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***Observational Study***

**Clinical value of liver and spleen shear wave velocity in predicting the prognosis of patients with portal hypertension**

ZhangY *et al*. Shear wave velocity predicting the prognosis

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**Abstract**

***AIM***

To explore the relationship of liver and spleen shear wave velocity of patients with liver cirrhosis combined with portal hypertension, and assess the value of liver and spleen shear wave velocity in predicting the prognosis of patients with portal hypertension.

***METHODS***

All 67 patients with liver cirrhosis diagnosed as portal hypertension by hepatic venous pressure gradient in our hospital from June 2014 to December 2014 were enrolled into this study. The baseline information of these patients were recorded. Furthermore, 67 patients were followed-up at 20 mo after treatment, and liver and spleen shear wave velocity were measured by acoustic radiation force impulse (ARFI) at the 1st wk, 3rd mo and 9th mo after treatment. Patients with favorable prognosis were assigned into the favorable prognosis group, while patients with unfavorable prognosis were assigned into the unfavorable prognosis group. The variation and difference in liver and spleen shear wave velocity in these two groups were analyzed by repeated measurement analysis of variance. Meanwhile, in order to evaluate the effect of liver and spleen shear wave velocity on the prognosis of patients with portal hypertension, Cox’s proportional hazard regression model analysis was applied. The ability of those factors in predicting the prognosis of patients with portal hypertension was calculated through ROC curves.

***RESULTS***

The liver and spleen shear wave velocity in the favorable prognosis group revealed a clear decline, while those in the unfavorable prognosis group revealed an increasing tendency at different time points. Furthermore, liver and spleen shear wave velocity was higher in the unfavorable prognosis group, compared with the favorable prognosis group; and the differences were statistically significant (*P <* 0.05). The prognosis of patients with portal hypertension was significantly affected by spleen hardness at the 3rd mo after treatment (RR = 3.481). At the 9th mo after treatment, the prognosis was affected by liver hardness (RR = 5.241) and spleen hardness (RR = 7.829). The differences between these two groups were statistically significant (*P <* 0.05). The ROC analysis revealed that the area under curve (AUC) of spleen hardness at the 3rd mo after treatment was 0.644, while the AUC of liver and spleen hardness at the 9th mo were 0.579 and 0.776, respectively. These might predict the prognosis of patients with portal hypertension.

***CONCLUSION***

Spleen hardness at the 3rd mo, and liver and spleen shear wave velocity at the 9th mo may be used to assess the prognosis of patients with portal hypertension. This is hoped to be used as an indicator of predicting the prognosis of patients with portal hypertension.

**Key words:** Liver cirrhosis; Portal hypertension; Liver and spleen shear wave velocity; Acoustic radiation force impulse

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**Core tip:** Sixty-seven patients with liver cirrhosis with portal hypertension were assessed by acoustic radiation force impulse Imaging at different time point after treatment. We found that the portal hypertension was significantly affected by spleen hardness at the 3rd mo after treatment (RR = 3.481). At the 9th mo after treatment, the prognosis was affected by liver hardness (RR = 5.241) and spleen hardness (RR = 7.829). The ROC analysis revealed that the area under curve of liver and spleen hardness might be used to predict the prognosis of patients with portal hypertension.

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**INTRODUCTION**

Portal hypertension is a common cause of cirrhosis and presents a series of symptoms[1,2]. In recent years, with the increase in incidence of liver cirrhosis, the number of patients with portal hypertension has rapidly increased[3]. The main clinical manifestations of portal hypertension are hepatosplenomegaly and ascites, which bring great negative impact on patients[4]. Due to its hard texture and obvious symptoms, splenomegaly associated with portal hypertension is significantly different from others, and is regarded as one of the main features of portal hypertension[5-7]. In clinical practice, severe complications of portal hypertension including gastric fundus, esophageal varices, hepatic encephalopathy and gastrointestinal bleeding have increased the risk of exacerbation, and even death[8-11]. In order to avoid complications and reduce the mortality of patients, early and effective evaluation indicators should be developed for predicting the prognosis. As a new technology of ultrasonic elastography, acoustic radiation force impulse imaging acoustic radiation force impulse (ARFI) can quantitatively reflect the advantages of tissue hardness by detecting the degree of deformation of the organ after compression, in order to assess the elasticity and hardness of tissues[12-15]. These detected results are displayed through imaging[16,17]. Although the clinical value of ARFI in predicting liver fibrosis, tumors and other diseases has been confirmed[18,19], researches on ARFI for detecting portal hypertension caused by cirrhosis have not been studied in detail. Hence, it remains to be determined whether ARFI has the ability to detect and evaluate portal hypertension prognosis. Therefore, in this study, liver and spleen ARFI shear wave velocity values were determined to evaluate the clinical significance of ARFI for detecting portal hypertension caused by liver cirrhosis in patients, aiming to provide predictive indications for the prognosis of patients and avoid complication and death.

**MATERIALS AND METHODS**

***Study object***

A total of 67 patients with liver cirrhosis, who were diagnosed with portal hypertension by hepatic venous pressure gradient (HVPG) in our hospital from June 2014 to December 2014, were included into this study. Among these patients, 42 patients were male and 25 patients were female; and the age of these patients ranged within 20-70 years old, with an average age of 52.68 ± 7.43 years old. This research was approved by the Ethics Committee of our hospital, and all patients provided a signed informed consent.

***Inclusion and exclusion criteria***

Inclusion criteria: (1) patients diagnosed with liver cirrhosis through clinical symptoms combined with laboratory or image examinations; (2) patients with HVPG ≤ 12 mmHg; and (3) patients classified as grade A or B in the child-pugh grading criteria. Exclusion criteria: (1) patients whose shear wave velocity values could not be acquired by ARFI; (2) patients with liver cancer or other complications; (3) patients with acute heart failure, cardiogenic shock, or other vital organs diseases; (4) patients who underwent splenic surgery; (5) patients whose hepatosplenomegaly was caused by acute infection and other reasons; and (6) patients who were receiving propranolol hydrochloride or other drugs that can affect portal pressure.

***Instruments and methods***

All 67 patients underwent routine clinical examinations at the day of hospitalization, and the serological indicators of liver function and clinical symptoms of these patients were recorded. After treatment, liver and spleen ARFI shear wave velocity was measured continuously for all patients for one week, and the results were recorded. Patients were instructed to fast at least eight hours before the measurement. A Siemens Acuson S2000 ultrasound system was used with a 4C1 convex array probe. During the liver shear wave velocity measurement, patients were asked to completely hold their breath and lie on the irright side (Figure 1A). The probe was kept vertically fixed on the intercostal space to avoid larger blood vessels. This was repeated three times, and measurement results averaged. During the spleen shear wave velocity measurement, patients were instructed to hold their breath and lie on their left side (Figure 1B). These steps were repeated and the mean shear wave velocity values were recorded.

***Follow-up***

All 67 patients were followed-up for 20 mo after treatment. The first follow up was at the 1st mo, and subsequent follow ups were performed by telephone every three mos. At the 3rd and 9th mo, the liver and spleen ARFI shear wave velocity values of patients were measured, and the results were recorded. The endpoint of this study was the unfavorable prognosis of patients during the follow-up period, which include complications or death after treatment. After the follow-ups, initial results upon admission and results of the last follow up were collected. In addition, the number of patients with unfavorable prognosis, serological indicators, the liver and spleen shear wave velocity values at the 1st wk and at the 3rd and 9th mo after treatment, and the diagnosis of the physician were recorded. Patients who were lost, refused visit, quit or died from other causes unrelated to the study were defined as censored.

***Data processing after follow-up***

During the 20-mo follow-up period, patients with favorable prognosis were assigned into the favorable prognosis group, while patients with unfavorable prognosis were as assigned into the unfavorable prognosis group. At the end of the follow-up period, baseline information, prognosis results, the serological indicators of liver function, and liver and spleen ARFI shear wave velocity measurements were analyzed. The baseline information of patients included age and gender. The prognosis results were classified as either favorable prognosis or unfavorable prognosis. The serological indicators of liver function included ALB, ALT and AST.

***Statistical analysis***

SPSS 19.0 was used for statistical analysis. Shear wave velocity values, the values of serological indicators ALB, AST and ALT and other measurement data were presented as mean ± SD. The unfavorable prognosis rate of patients and follow-up results were expressed *via* survival curve and pie chart, respectively, to analyze the prognosis of patients with portal hypertension. The variation and difference of shear wave velocity values in these two groups at the 1st wk and the 3rd and 9th mo after treatment were compared using repeated measures analysis of variance to explore the relationship between shear wave velocity values at different time points and portal hypertension. Age, gender, prognosis results, ALT, ALB and AST shear wave velocity values and other possible influences were included in the Cox’s proportional hazard regression model analysis; and indicators that affected prognosis were selected. On this basis, the ROC curve was used to further compare with the area of all indicators that have statistically significant differences area under curve (AUC), and investigate the ability of indicators that could predict the prognosis of patients with portal hypertension. *P <* 0.05 was considered statistically significant.

**RESULTS**

***Analysis of follow-up results and unfavorable prognosis rate***

The follow-up results revealed 29 patients in the favorable prognosis group and 34 patients in the unfavorable group. Among these patients, 11 patients died, 60 patients had adverse complications, and 4 patients were lost to follow-up. The Kaplan-Meier survival curve was used to analyze the incidence of portal hypertension complications after treatment. Results revealed that the unfavorable prognosis rate was 58.97%, as shown in Figures 2 and 3.

***Comparison of liver shear wave velocity values between the favorable prognosis group and unfavorable prognosis group***

The analysis results of variations in liver shear wave velocity values revealed that the liver shear wave velocity value in the unfavorable prognosis group exhibited an increasing trend, while a clear decline was observed in the favorable prognosis group (*F*within group = 2.106, *P*within group = 0.039). The livers hear wave velocity value was highest at the 1st week after treatment in the favorable prognosis group, which gradually decreased thereafter. This value was lowest at to 9th mo after treatment. However, in the unfavorable prognosis group, the liver shear wave velocity value was highest at the 9th mo and lowest at the 1st wk after treatment. The liver shear wave velocity values of these two groups were compared among different time points. Although these values in the favorable prognosis group were slightly higher than those in the unfavorable prognosis group, and the difference was not statistically significant (*P >* 0.05). Furthermore, the difference in liver shear wave velocity values at the 3rd and 9th mo was statistically significant (*P <* 0.05), and these values in the favorable prognosis group were lower. Overall, the liver shear wave velocity values in the unfavorable prognosis group were higher than those in the favorable prognosis group; and the difference was statistically significant (*F*between groups = 2.193, *P*between groups = 0.032). Furthermore, these values correlated between the different groups or among different times points (*F*interaction = 2.457, *P*interaction = 0.017) (Table 1, Figure 4).

***Comparison of spleen shear wave velocity values between the favorable prognosis group and unfavorable prognosis group***

In the favorable prognosis group, the spleen shear wave velocity values declined from the 1st wk to the 9th mo after treatment. The values at the 1st wk was highest and the value at the 9th mo was lowest. However, spleen shear wave velocity values in the unfavorable prognosis group exhibited an increasing trend. The minimum and maximum values of the liver shear wave velocity were reached at the 1st week and 9th mo after treatment, respectively. Values at the different time points of these two groups are presented in Table 2.There results revealed that spleen shear wave velocity value sat the 3rd and 9th mo in the unfavorable prognosis group were higher, and the difference was statistically significant (*P <* 0.05). Furthermore, values at the 1st wk in these two groups were similar, and the difference was not statistically significant (*P >* 0.05). The spleen shear wave velocity values were compared between these two groups. These results revealed that values in the unfavorable prognosis group were higher than in the favorable prognosis group, and the difference was statistically significant (*F*between groups = 8.431, *P*between groups = 0.000). The values in different groups or at different time pointswere correlated (*F*interaction = 3.422, *P*interaction = 0.001; Figure 5).

***Evaluation of the effects of suspicious indicators using the Cox’s proportional hazard regression model***

A Cox’s proportional hazard regression model was constructed to analyze the effects of all suspicious indicators on portal hypertension prognosis. These results revealed that the age and gender of patients had no effect on prognosis (*P >* 0.05), and serological indicators including ALB, AST and ALT did not influence the prognosis. At the same time, all liver and spleen shear wave velocity values at different time points were evaluated, and results revealed that liver shear wave velocity values at the 9th mo, and spleen shear wave velocity values at the 3rd and 9th mo could affect the prognosis of patients (*P <* 0.05); while other values had no significant effects (*P >* 0.05). All indicators that had statistically significant differences were compared. The spleen shear wave velocity value at the 9th mo after treatment had the strongest effect on the prognosis of patients (RR = 8.829). The liver hardness value at the 9th mo ranked second (RR = 6.271), followed by the spleen hardness value at the 3rd mo (RR = 3.481), as shown in Table 3.

***Comparison of the ability of liver shear wave velocity values at the 9th mo and spleen shear wave velocity values at the 3rd and 9th mo for predicting prognosis***

In order to analyze the predictive ability of these three indicators for adverse prognosis, the ROC curve was established. This revealed that the AUC of spleen shear wave velocity values at the 3rd mo, and the AUC of the liver and spleen shear wave velocity values at the 9th mo were 0.644, 0.579 and 0.776, respectively. It was found that the AUC of the spleen shear wave velocity value at the 9th mo was highest. The sensitivity was 55.9%, specificity was 89.7% and the best diagnostic value was 0.455. Furthermore, the AUC of the spleen shear wave velocity value at the 3rd mo was slightly lower; and the sensitivity, specificity and best diagnostic value was 70.6%, 58.6% and 0.292, respectively. The lowest AUC was the liver shear wave velocity value at the 9th mo, and the sensitivity, specificity and best diagnosis value was 73.5%, 48.3% and 0.218, respectively (Figure 6).

**DISCUSSION**

Portal hypertension is a clinical syndrome caused by portal venous drainage obstruction. This occurs in middle-age men and develops slowly, and most of these are closely associated with cirrhosis[20-23]. In China, the number of new patients with cirrhosis increase year after year[24]. At the same time, the incidence of portal hypertension has also rapidly increased[25].The majority of patients often present with liver dysfunction, bleeding, gastrointestinal vascular disease and other serious diseases, except common clinical symptoms including hepatosplenomegaly and ascites[26]. At present, the main approaches for the clinical treatment of portal hypertension are surgery and symptomatic treatment[27]. Although these treatment approaches are diverse and effective, the mortality rate of patients who have this disease remains high due to delitescent pathogenetic condition, long disease duration and proneness to complications[28].Therefore, it is important to establish a simple and effective system for the prognosis of portal hypertension, in order to monitor the disease, adjust the treatment approaches, and improve the survival rate of patients in real time. The varying degrees of hardness of the lesions are usually related to the severity of the disease[29]. Furthermore, the swelling and hardness of the hepatosplenomegaly of portal hypertension are more visible than those of other diseases[30,31]. This shows that there may be relationships between liver and spleen hardness and portal hypertension[32-34]. In the present study, it was shown that studies have investigated the relationship between liver and spleen hardness and liver fibrosis, chronic liver, or other liver diseases[35,37]. However, there is lack of further research on the relationship between liver and spleen hardness and portal hypertension, and the clinical value of liver and spleen hardness in evaluating the prognosis of portal hypertension could not be determined. In recent years, as a mature method of examination, ARFI imaging promotes the implementation of detecting tissue hardness to predict the development of diseases[38,39]. Due to its simple, convenient and good repeatability advantages, ARFI imaging has gained the attention of clinicians. Hence, we detected the liver and spleen ARFI shear wave velocity values of these patients and analyzed their prognosis, in order to evaluate the clinical application value of ARFI in predicting the prognosis of portal hypertension.

***Analysis of unfavorable prognosis rates and the comparison of liver and spleen shear wave velocity values in these two groups***

The common adverse complications of portal hypertension include esophageal and gastric variceal bleeding, hepatic encephalopathy, hepatorenal syndrome and others; which are the main indications of surgery for treating portal hypertension[40]. Among these complications, esophageal and gastric variceal bleeding was the most dangerous[41,42]. When this occurs, patients will be at risk due to acute upper gastrointestinal bleeding[43,45]. Therefore, it has been considered that the establishment of a prognostic detection system for portal hypertension has clinical value[46-48]. In this study, patients were enrolled according to the child-pugh criteria and HVPG results. Patients classified as grade C and had an HVPG ≥ 12 mmHg were excluded due to higher risk of surgery, lower survival rate and poor recovery. The Kaplan-Meier survival curve revealed that the unfavorable prognosis rate in all 67 patients was 58.97% at the end of follow-up, which reflects that it is unsatisfactory of the prognosis of patients with portal hypertension. In order to investigate the variation trend of liver and spleen shear wave velocity values, values at three different time points are collected and analyzed by repeated measures analysis of variance. Results revealed that the liver and spleen shear wave velocity values in the favorable prognosis group exhibited a decreasing trend, and there were significant differences in these values at three different time points. Values are lowest in the favorable prognosis group at the 9th mo, but the variations in these values in the unfavorable prognosis group were the opposite. This suggests that there may be a link between the variation in liver and spleen shear wave velocity values and the development of portal hypertension. When comparing the overall values of liver and spleen shear wave velocity in these two groups, values in the unfavorable prognosis group was significantly higher than in the favorable prognosis group. This demonstrates that there is a potential relationship between liver and spleen shear wave velocity and the prognosis of patients with portal hypertension[49-51].

***Comparative analysis of indicators that affect the prognosis of patients***

In order to further investigate indicators that affect the prognosis of portal hypertension, Cox’s proportional hazard regression model was performed on liver function serum markers, clinical date and liver and spleen shear wave velocity values at three different time points. As common clinical detection indicators, liver function serum markers were detected to reflect the degree of liver damage. In this study, ALB, ALT and AST were included into the Cox’s regression model to evaluate their effect on the prognosis of patients with portal hypertension. Results revealed that liver function serum markers ALB, ALT and AST have no significant effect on the prognosis of this disease. The reasons may be that the variation in ALB, ALT, and AST values are also associated with many diseases such as hepatitis, myocarditis and Japanese B encephalitis, except for cirrhosis. Hence, liver function markers have low sensitivity on the diagnosis and prediction of diseases. Therefore, it is unsatisfied to take serum markers of liver function as a prognostic indicator of portal hypertension. In the contrary, in analyzing liver and spleen shear wave velocity values at three different time points, it is can be found that the spleen shear wave velocity value at the 3rd mo and liver and spleen shear wave velocity value at the 9th mo can significantly affect the prognosis of portal hypertension. Among these indicators, the effect of the spleen shear wave velocity value is the most significant, while the value at the 3rd mo was the lowest. However, liver and spleen hardness at the 1st wk after treatment had no significant effect. This may be due to the improvement of the liver and spleen in the short period after treatment. In addition, the liver shear wave velocity value also has no effect on the prognosis of this disease. The possible reason is that that liver hardness is not a feature of portal hypertension, this value can be affected by many factors, and the variation degree is similar. The results of this study show that spleen hardness at the 3rd mo and liver and spleen hardness at the 9th mo have the potential to assess the prognosis of portal hypertension.

***Comparison of the ability of liver and spleen shear wave velocity values at different time points in predicting the prognosis of portal hypertension***

Based on the above data, the ROC curve was constructed to further investigate the predictive ability of liver hardness at the 9th mo and spleen hardness at the 3rd and 9th mo. As a result, the AUC of the spleen shear wave velocity value at the 9th mo was highest, which was over 0.7. This revealed that this value had a better predictive ability on the prognosis of portal hypertension, while the AUC of liver hardness at the 9th mo and spleen hardness at the 3rd mo are lower, and their predictive ability are slightly insufficient. The comprehensive analysis shows that the liver shear wave velocity values at the 9th mo and the spleen shear wave velocity values at the 3rd and 9th mo are expected to be used as predictive indicators for the prognosis of the patients with portal hypertension. Furthermore, this can be combined with other prognosis detection indictors in evaluating the risk of patients.

However, our study still has some deficiency, which includes the small sample data, the inadequate time points for ARFI detection, and the lack of coverage on other types of portal hypertensions. Therefore, future studies with larger samples and adequate detection time points should be conducted to evaluate the other types of portal hypertensions and verify our findings.

In summary, liver and spleen ARFI shear wave velocity values have the potential to monitor the prognosis of portal hypertension, and liver shear wave velocity values at the 9th mo and spleen shear wave velocity values at the 3rd and 9th mo can reflect the prognosis of patients. It is hoped that this approach could be applied in clinic to reduce complications and improve the survival rate of patients.

**comments**

***Background***

Portal hypertension is a common cause of cirrhosis and presents a series of serious symptoms. In recent years, The incidence rate of liver cirrhosis as well as the portal hypertension rate in china are increasing. The main clinical symptoms of portal hypertension are hepatosplenomegaly and ascites, which bring great negative impactations on patients. Because of the hard texture and obvious symptoms, splenomegaly associated with portal hypertension is regarded as one of the main features of portal hypertension. In clinical practice, severe complications of portal hypertension including gastric fundus, esophageal varices, hepatic encephalopathy and gastrointestinal bleeding have increased the risk of exacerbation, and even death.

***Research frontiers***

Acoustic radiation force impulse imaging acoustic radiation force impulse (ARFI)can quantitatively reflect the advantages of tissue hardness by detecting the degree of deformation of the organ after compression, in order to assess the elasticity and hardness of tissues. These detected results are displayed through imaging. Although the clinical value of ARFI in predicting liver fibrosis, tumors and other diseases has been confirmed, researches on ARFI for detecting portal hypertension caused by cirrhosis have not been studied in detail.

***Innovations and breakthroughs***

ARFI could be used to determine liver and spleen hardness by detecting the degree of deformation of the organ after compression. ARFI is convinent, non-invasive and simple. In this study, we use the technology to figure out the relation between portal hypertendion and try to evaluate the predict value for protal hypertension.

***Applications***

The study illustrated the ability for ARFI to be applied to detecting portal hyperhension in clinical practice. The prognosis of patients with portal hypertension was significantly affected by spleen and liver hardness. Spleen hardness at the 3rd mo, and liver and spleen shear wave velocity at the 9th mo may be used to assess the prognosis of patients with portal hypertension. It's expected to be used as an indicator of predicting the prognosis of patients with portal hypertension.

***Peer- review***

This study illustrated that ARFI imaging could be used in detecting portal hypertension by detecting liver and spleen harshness. SWV is a quantitative indicator which is accurate and objective. The detecting process of ARFI is simple, no-invasive, fast and widely used in detecting and predicting in clinical practice. Thus, ARFI imaging is a helpful tool that has an significant clinical value and is worthy of developing.

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B

A

**Figure 1 Measurement of liver and spleen hardness in patients with acoustic radiation force impulse were performed and recorded.** A: for the liver hardness, SWV = 1.42 m/s; B: for the spleen hardness, SWV = 1.97 m/s.



**Figure 2 Analysis of the survival curve for the unfavorable prognosis rate of patients with portal hypertension.**

**Figure 3 The results of follow-up.**

**Figure 4 Variations of liver shear wave velocity values between the two groups at the 1st wk and at the 3rd and 9th mo after treatment.**

**Figure 5 Variations of spleen shear wave velocity values between the two groups at the 1st wk, 3rd mo and 9th mo after treatment.**



**Figure 6 The ROC curves of liver and spleen hardness in predicting the prognosis of patients with portal hypertension.**

**Table 1 Comparison of the liver shear wave velocity values of the two groups at the 1st wk and at the 3rd and 9th mo after treatment (mean ± SD)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Group** | **1st week after treatment (m/s)** | **3rd mo after treatment (m/s)** | **9th mo after treatment (m/s)** |
| Favorable prognosis group | 1.88 ± 0.39 | 1.70 ± 0.41 | 1.67 ± 0.38 |
| Unfavorable prognosis group | 1.84 ± 0.43 | 1.92 ± 0.43 | 2.08 ± 0.35 |
| *t* | 0.384 | 2.068 | 4.455 |
| *P* value | 0.702 | 0.043 | 0.000 |

a*P* < 0.05,b*P* < 0.01 *vs* favorable prognosis group; (1) *F*within group = 2.106, *P*within group = 0.039; (2) *F*between groups = 2.193, *P*between groups = 0.032; (3) *F*interaction = 2.457, *P*interaction = 0.017.

**Table 2 Comparison of spleen shear wave velocity values between the two groups at the 1st wk, 3rd mo and 9th mo after treatment (mean ± SD)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Group** | **1st week after treatment (m/s)** | **3rd mo after treatment (m/s)** | **9th mo after treatment (m/s)** |
| Favorable prognosis group | 3.82 ± 0.44 | 3.71 ± 0.42 | 3.55 ± 0.34 |
| Unfavorable prognosis group | 3.83 ± 0.46 | 4.06 ± 0.44 | 4.29 ± 0.30 |
| *t* | 0.088 | 3.213 | 9.178 |
| *P* value | 0.930 | 0.002 | 0.000 |

a*P* < 0.01 *vs* favorable prognosis group; (1) *F*within group = 2.544, *P*within group = 0.013; (2) *F*between groups = 8.431, *P*between groups = 0.000; (3) *F*interaction = 3.422, *P*interaction = 0.001.

**Table 3 Cox’s proportional hazard regression model analysis of the prognosis of patients with portal hypertension**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **B** | **SE** | **Wald** | **df** | ***P* value** | **RR** | **95%CI** |
| **Upper limit** | **Lower limit** |
| ALB | -0.030 | 0.083 | 0.131 | 1 | 0.718 | 0.970 | 0.824 | 1.143 |
| ALT | -0.014 | 0.021 | 0.415 | 1 | 0.520 | 0.986 | 0.946 | 1.028 |
| AST | -0.007 | 0.028 | 0.068 | 1 | 0.794 | 0.993 | 0.939 | 1.049 |
| Gender | -0.909 | 0.615 | 2.181 | 1 | 0.140 | 0.403 | 0.121 | 1.346 |
| Age | 0.016 | 0.036 | 0.192 | 1 | 0.661 | 1.016 | 0.947 | 1.090 |
| Liver hardness in the 1st week after treatment | 0.175 | 0.698 | 0.063 | 1 | 0.802 | 1.191 | 0.304 | 4.676 |
| Liver hardness in the 3rd mo after treatment | 1.155 | 0.769 | 2.258 | 1 | 0.133 | 3.175 | 0.704 | 14.329 |
| Liver hardness in the 9th mo after treatment | 1.657 | 1.123 | 3.930 | 1 | 0.047 | 5.241 | 1.026 | 83.802 |
| Spleen hardness in the 1st week after treatment | 0.034 | 0.024 | 2.089 | 1 | 0.148 | 1.035 | 0.988 | 1.084 |
| Spleen hardness in the 3rd mo after treatment | 1.247 | 0.583 | 4.576 | 1 | 0.032 | 3.481 | 1.110 | 10.914 |
| Spleen hardness in the 9th mo after treatment | 2.058 | 0.883 | 6.079 | 1 | 0.014 | 7.829 | 1.563 | 49.870 |