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Grading of Liver Cirrhosis Using Ultrasound

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Abstract: ***This study was aimed to classify and grade the liver cirrhosis in US images using ultrasonographic features in order to classify the liver grades into different classes according to the degree of fibrotic changes. An analytical case control study of abdominal ultrasound images of 53 adult subjects with liver cirrhosis. An ultrasound characteristics of different liver grade including (texture, echogenicity, and cirrhosis grade and ascites condition), was collected and analyzed using linear discriminant analysis used for the tissue classification. Also cross tabulation was done to assess the relationship between all these variables and liver grades. The study found that the cirrhosis texture reveal a different underlying pattern compared to the cyst and normal liver tissues with classification sensitivity for grade 0, 1, and 2 are 91.4%, 63.6% and 57.1% respectively. The combination of the texture features throughout the different U/S image phases using linear discriminant analysis technique also was classified and the sensitivity and overall accuracy demonstrated here.***

Keywords: liver, liver cirrhosis, Grade, fibrosis

1. Introduction

Chronic liver disease (CLD) is a significant cause of morbidity and mortality in developed nations. It is commonly caused by viral hepatitis and alcohol abuse with significant contributions from metabolic disorders [1]. Accurate diagnostic testing for CLD to identify asymptomatic patients in a high risk population has become more important due to recent advances in management and treatment options that provide better patient outcomes if the diagnosis of fibrosis or cirrhosis can be made before cirrhosis becomes clinically apparent [2]. In some cases, liver fibrosis has been demonstrated to be reversible [3], a phenomenon that was previously not considered possible.

The standard method for determining, staging and grading CLD is liver biopsy [4]. The invasiveness of this method, and its associated morbidity and mortality has led to the emergence of less invasive methods which include medical imaging techniques (computed tomography, magnetic resonance imaging and ultrasound), serum markers (both direct and indirect markers of fibrosis) and transient elastography [2]. All of these techniques have the potential to reduce the number of biopsies performed in a high risk population.

Ultrasound can identify the manifestations of CLD such as liver fibrosis and cirrhosis which are characterized by the presence of vascularized fibrotic septa and regenerating nodules [1, 5, and 6]. Ultrasound is an attractive diagnostic tool because it is readily available, inexpensive, and well tolerated and is already extensively used in the diagnostic work-up of patients with CLD. The diagnostic accuracy of ultrasound needs to be established to inform clinicians of its role in patients at high risk of CLD.

2. Liver Cirrhosis

Cirrhosis is a diffuse hepatic process characterized by fibrosis and the conversion of normal liver architecture into structurally abnormal nodules. Cirrhosis represents the final histological pathway for a wide variety of liver diseases. The progression to cirrhosis is very variable and may occur over weeks or many years. [1] Around 80-90% of the liver parenchyma needs to be destroyed before there are clinical signs of liver failure. [2] However, there is often a poor correlation between the histological findings and the clinical picture.

The fibrosis causes distortion of the hepatic vasculature and can lead to an increased intrahepatic resistance and portal hypertension. Portal hypertension can lead to esophageal avarices as well as hypo perfusion of the kidneys, water and salt retention and increased cardiac output.[3] Damage to liver cells (hepatocytes) causes impaired liver function and the liver becomes less able to synthesize important substances such as clotting factors and is also less able to detoxify other substances.

2.1. Cirrhosis – Liver Stages

Stage #1: This is the initial stage of cirrhosis. During the initial stages the patients may experience very few symptoms and it may progress very slowly. If Cirrhosis is diagnosed in this early stage, the patient has a good rate of survival. The general symptoms include jaundice, dry mouth, fatigue and enlargement of the upper stomach area. Some patients even suffer from itchiness all over their body. It's very easy to eliminate cirrhosis in the initial stages. A doctor may diagnosis from physical examination, a biopsy, blood test or *ultrasound.* Proper and prompt medical care is very important for the wellbeing of the patient. In the initial stages the cirrhosis patients will suffer from abnormal tissue enlargement and inflammation. An improvement or decrease in liver disease is verified by a liver biopsy.

Stage #2:

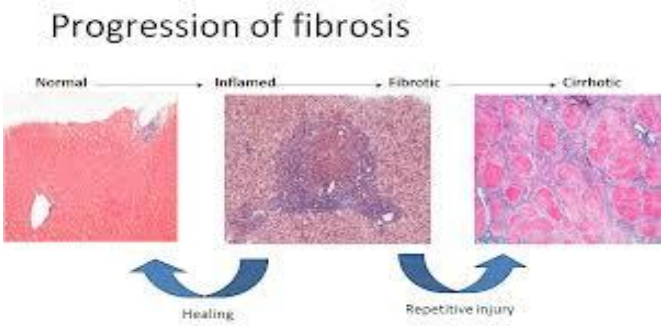

Figure 1: Demonitrate the stages of liver cirrohsis from normal to cirrohsis.

Without proper medical care stage 1 will progress to the level of stage two. The abnormal damaged tissues formed in initial stage begin to transform into stiff rigid bands of connective tissue. The transformation of cell tissue into these rigid bands is known as fibrosis. The inflammation and fibrosis will spread to the patient's portal veins and periportal regions, greatly affecting the flow of blood through the liver.

Stage #3: In stage three, the rigid band of connective tissue formed in the second stage merge with each other. The merging process causes huge enlargement in the affected areas. The enlargement leads to disturbance of normal liver functions. The liver is unable to store nutrients, support blood streaming, or break down fat contents from blood. It is within stage 3 the person may experience an inability to digest fats. Vitamin deficiency may also be noticed due to the inability to absorb fat-soluble vitamins. The liver stops removing toxic protein content from the bloodstream. Cirrhosis in this stage leads to several kidney, spleen and heart problems in humans.

Stage #4: This is final stage of Cirrhosis of the liver. This stage is considered to be the most deadly stage. The cirrhosis infected patient has little chance of survival in this stage. The patient needs to opt for a liver transplantation at his or her own risk. In this stage, many of the symptoms will increase considerable because the liver is unable to detoxify the blood and this may even lead to severe confusion and at worst, coma. There may be kidney failure, spleen enlargement and a loss of bone mass and drop in bone density.

3. Material and Methods

The study was done in 53 patients were exposed to bilharzaisis using 2D conventional ultrasound to diagnosis the changes in the liver. All patients scanning by ultrasound using curvilinear low frequency probe (3.5 – 5 MHZ) for more panteration sonyscape machine by using an international scan guidelines protocols to scanning liver using ultrasonography. The grade of fibrosis relative to the ultrasound characteristics was extracted and then classified into different class according to the grading here from mild (0) to sever (3).

4. Result and Discussion

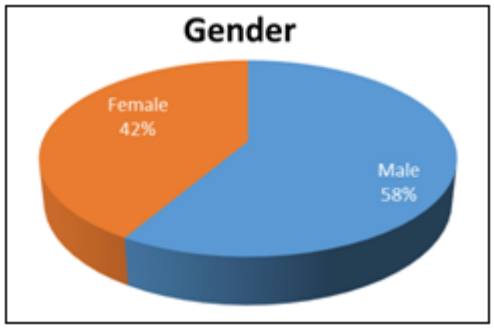

Figure 1: Frequency distribution of liver cirrhosis for gender

Most of patients are male about 58% and the most of them are farmer about 39.6% of all patients that indicate the occupation play role of exposed to disease.

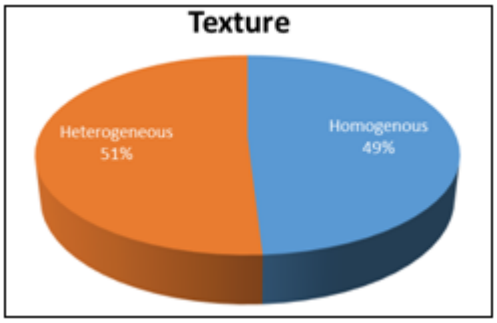

Figure 2: Frequency distribution of liver cirrhosis using texture of liver.

Most of patients are show heterogeneous texture of liver about 51% and 49% are homogenous but are no big difference for this is unreliable finding.

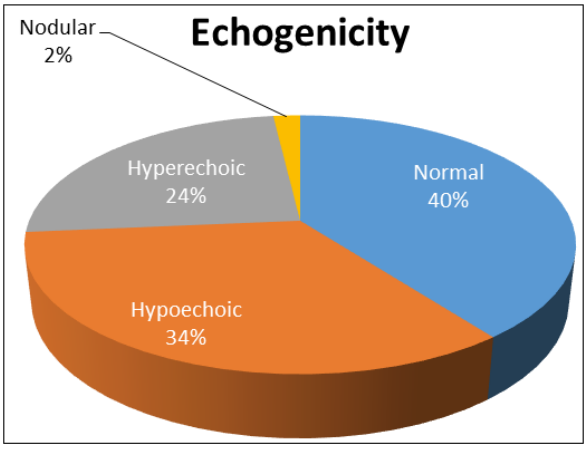

Figure 3: Frequency distribution of liver cirrhosis using liver echogenicity.

Echogenicity distributed the patients as 40% are normal, 34% hypo echoic, 24% hyper echoic and 2% nodular.

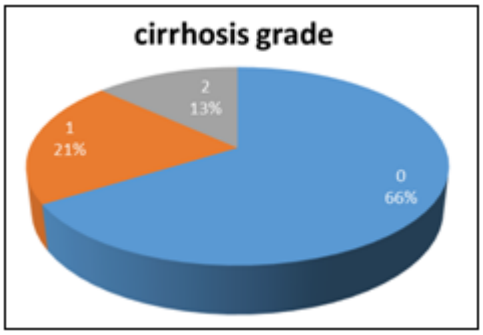

Figure 4: Frequency distribution of liver cirrhosis grading using ultrasound.

Grading of liver cirrhosis is distributed as 66% are grade 0, 21% grade 1 and 13% are grade 3.

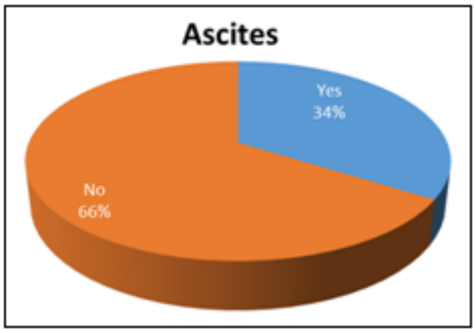

Figure 5: Frequency distribution of liver cirrhosis using ascites.

Ascites is divided the patients to 34% have ascites and 66% have no ascites.

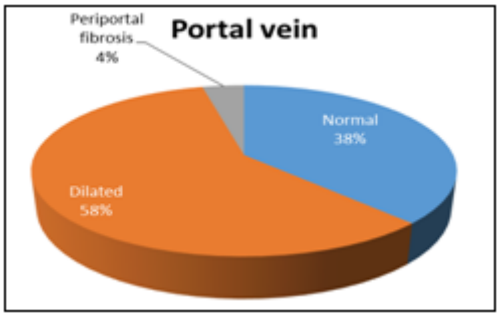

Figure 6: Frequency distribution of liver cirrhosis using portal vein

Most of the patients are diagnosis as dilated portal vein are 58%, 38% are normal and 4% were periportal fibrosis.

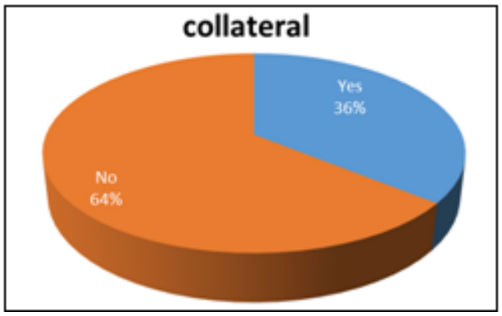

Figure 7: Frequency distribution of liver cirrhosis using collateral

Most of patients have no collateral about 64% and the others are have collateral about 36%.

Table 1: Cross tabulation between the texture and grades

Texture	cirrhosis grade			Total
	0	1	2	
Homogenous	45.4%	1.8%	1.8%	49.1%
Heterogeneous	20.8%	18.9%	11.3%	50.9%
Total	66.2%	20.7%	13.1%	100%

The texture is unreliable finding in cirrhosis grade because texture will affected by other factor such as gain.

We noted a homogenous echo texture for grade (0), but as the disease progressed the heterogeneity in the appearance will be predominant and in table. 1.

Table 2: Cross tabulation between the grades and echogenicity

Echogenicity	cirrhosis grade			Total
	0	1	2	
Normal	37.7%	0%	1.9%	39.6%
Hypoechoic	22.6%	5.7%	5.7%	34%
Hyperechoic	5.7%	13.2%	5.7%	24.6%
Nodular	0%	1.8%	0%	1.8%
Total	66%	20.7%	13.3%	100%

Echogenicity is play key role in grade of cirrhosis because all most of normal are found in grade 0 about 37.7% of patients and 1.9% of patients in grade 2.

Table 3: Show the relation between ascites and cirrhosis

Ascites	cirrhosis grade			Total
	0	1	2	
Yes	7.5%	13.2%	13.2%	33.9%
No	58.6%	7.5%	0%	66.1
Total	66.1%	20.7%	13.2%	100%

Ascites is significant affected in grade of cirrhosis all most of ascites patients are found in grade 1 and 2 patients as the same percent 13.2% but about 7.5% found in grade (0).

Table 4: Show the relation between collateral and cirrhosis grade

Collateral	cirrhosis grade			Total
	0	1	2	
Yes	7.5%	17%	11.3%	35.8%
No	58.5%	3.8%	1.9%	64.2%
Total	66%	20.8%	13.2%	100%

Collateral play key role in grade of cirrhosis most of collateral are found in grade 1 and 2 by 17% and 11.3% patients but has 7.5% of them in grade (0) make it un reliable.

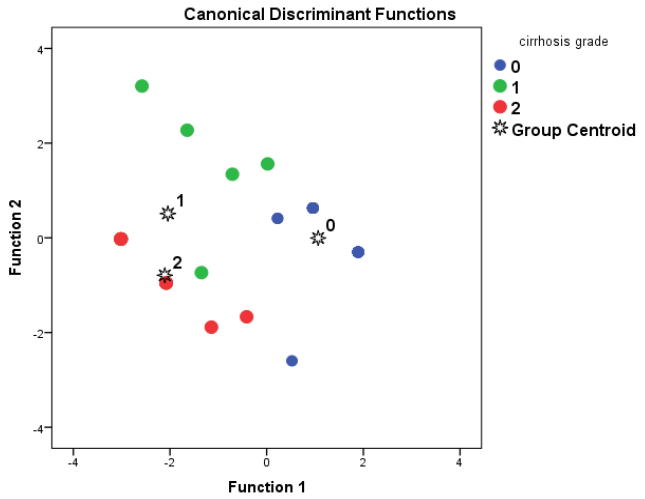

Fig 8. Classification map generated using LDA function
Table 4. Classification accuracy for predicted grades using LDA function

Table 5: Showed the original group classification using LDA

Cirrhosis Grade	Predicted Group Membership			Total
	0	1	2	
0	91.4	0	8.6	100
1	9.1	63.6	27.3	100
2	0	42.9	57.1	100
81.1% of original grouped cases correctly classified.				

This is analysis is more significant in grade of cirrhosis by give 81.1% of original grouped cases correctly classified using equation called linear discriminant equation.

5. Conclusion

In conclusion liver cirrhosis can be grade using ultrasound objectively with an accuracy of 81.1% using linear discriminant equation, where the vote for the grade in the equation will be to the highest value as follows:

Grade 0 = (2.445 × echogenicity) + (11.7×Ascites) + (11.64 ×collateral) -24.96
Grade 1 = (5.83 × echogenicity) + (8.63×Ascites) + (6.09 × collateral)-18.81
Grade 2 = (4.68 × echogenicity) + (5.55×Ascites) + (6.92 × collateral) -13.18

Echogenicity:
Normal = 1
Hypoechoic = 2
Hyperechoic = 3 and Nodular = 4
Ascites: Yes =1, No =2
Collateral: Yes= 1, No= 2
- By butting the value in each equation the large value can detect the grade of cirrhosis.

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