Liver diseases constitute a group of pathologies of extraordinary importance, because of the large number of patients who suffer from these as well as the consequences that they can have on these individuals if they undergo any surgical procedure. Therefore, these patients have greater risk of suffering unfavorable outcomes than a healthy person undergoing emergency neurosurgical procedures (ENP) for neurotrauma. For this reason, there is a need to classify these patients according to their surgical risk based on risk factors secondary to the concurrent hepatic derangements. Among the possible tools that allow us to stage patients with liver disease are the Child–Turcotte–Pugh (CTP) and model for end-stage liver disease (MELD) scales, which have proven utility in effectively predicting the outcomes, including morbidity and mortality in hepatic disease patients who are undergoing surgery. They also help to predict the risk of complications such as intracranial hemorrhage secondary to coagulopathy due to hepatic derangement.

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Overview

The adverse association between CLDs and surgery is clearly pronounced in literature, and liver cirrhosis has even been extensively described as a risk factor associated with increased morbidity and mortality.7–9 The morbidity rate in patients with liver cirrhosis has been reported in literature to be 52.1% with a mortality rate of 24.3%.10 Studies established that the greater the severity of the liver disease, the greater the risk of mortality and the poorer prognosis with neurosurgery.10,11 Severe liver disease itself complicates surgical procedures to a greater extent by various mechanisms including protein synthesis dysfunction which, in turn, leads to hypoproteinemia, difficulty in wound healing, and physical recovery from the procedure.12 Further, cirrhosis leads to portal hypertension that increases collateral circulations and hematological alterations of liver diseases such as deficiencies of coagulation factors, vitamin K and thrombocytopenia due to splenic sequestration that increase the risk of surgical bleeding.14,15

Preoperative Risk Factors in Patients with Liver Disease

It has been described that the presence of underlying liver disease is associated with poor postoperative results. CLD in itself encompasses many important complications, such as hepatic encephalopathy and coagulopathies,16 which lead to significant impact on any type of surgery. Neurosurgical patients are especially vulnerable to adverse outcomes due to risk of intracranial hemorrhage.17 This makes it fundamentally important for surgeons to know which preoperative risk factors could lead to poor outcomes in patients with liver disease at the time of neurological surgery.18 A study performed in 2018 with a large cohort of patients described that patients undergoing neurosurgical interventions with liver disease have a higher risk of mortality and an increase in hospital stay of more than 10 days compared with those without liver disorders.18 For this reason, surgeons must be cautious when considering a patient with liver disease as a candidate for neurosurgery. As a major preoperative risk factor, CLD deranges the coagulation system and thus not only leads to spontaneous intracranial hemorrhage requiring surgical treatment19 but also increases the risk of rebleeding, reoperations, and transfusion of blood products.20

Another risk factor that impacts postoperative outcomes is the nutritional status of patients with liver disease, since they have low levels of albumin preoperatively, which negatively impacts the healing of cranial wounds and increases chances of infections with lethal complications.21,22

Several independent risk factors with liver disease which increase the risk of devastating consequences in patients undergoing brain surgery include heart failure, kidney disease, stroke, and viral hepatitis as a cause of cirrhosis.23 For this reason, the identification and prompt correction of modifiable risk factors in patients with liver disease who require neurosurgical surgery become important to reduce the incidence of complications and improve postoperative outcomes.

Scales to Evaluate Liver Fibrosis

AST to Platelet Ratio Index (APRI index)
The APRI index indirectly evaluates the degree of fibrosis through the index between the level of the enzyme aspartate aminotransferase and the platelet counts.24 This has been recommended by the World Health Organization (WHO) to assess the degree of fibrosis in patients with hepatitis C due to its ease of performance and cost.25

A meta-analysis performed in 2009 which compiled data from 22 studies established a sensitivity of 81% and a specificity of 50% for determining liver fibrosis by the APRI index.26 Likewise, a retrospective study performed in 2016, which included 798 patients with chronic hepatitis C, also established a sensitivity for this test at 81% with an APRI cutoff point > 2 to define patients with cirrhosis.27 This sensitivity adds to the relationship that has been evident between the APRI score and the postsurgical outcome. This makes it useful at the time of the presurgical evaluation.18

\[
\text{APRI} = \frac{\text{AST/AST}(\text{upper limit of normal})}{\text{Platelet counts}} \times 100
\]

- < 0.5 rules out significant fibrosis
- > 1.5 rules in significant fibrosis
- > 2.0 cirrhosis

Child–Turcotte–Pugh (CTP) Score

This scale assesses the albumin level, bilirubin level, prothrombin time, international normalized ratio (INR), presence or absence of ascites and encephalopathy.27 According to the score obtained, the patients are classified in category A, B or C, giving a rate estimated mortality according to subgroups. Category A patients have a mortality rate between 5% and 10%, category B patients between 10% and 40%, and category C patients have a mortality rate of 20% to 100%, and this variability is determined by the associated comorbidities.27,28

Chen et al10 studied patients with liver cirrhosis who underwent brain surgery and concluded that patients with the progressive liver cirrhosis (based on the Child classification) who were undergoing brain surgery had poorer outcome. These studies allow neurosurgeons to have better guidance on decision-making when faced with a patient having concomitant liver disease. Based on the severity score, they will be able to calculate the risk of complications including mortality and determine the relevance of performing the procedure or not.18,27
going liver transplantation. 29

negative predictor in postoperative results in patients under-
level in its tests, as hyponatremia has been established as a

the severity of liver disease and surgical risk, from 2016, after

postsurgical complications in the cirrhotic patient are related

to the extent of liver injury, comorbidities, type of surgical
procedure, and medical expertise. Out of these factors, the
degree of dysfunction of liver disease appears to be the factor
with the greatest impact on risk of mortality. 27 In the neuro-
surgical setting, a life-threatening complication is intracra-
nial hemorrhage. However, it is sometimes can be overlooked
due to the clinical similarities of neurologic deficits, which
can be caused by hepatic encephalopathy. The evacuation of

Table 1 CTP score determining estimated mortality according

to subgroups

<table>
<thead>
<tr>
<th>Encephalopathy</th>
<th>Ascites</th>
<th>Bilirubin (mg/dl)</th>
<th>Albumin (g/dl)</th>
<th>PT prolonged (s)</th>
<th>INR</th>
<th>Child’s A = 5–6 points</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>&lt; 2</td>
<td>&gt; 3.5</td>
<td>1–4</td>
<td>&lt; 1.7</td>
<td>Child’s B = 7–9 points</td>
</tr>
<tr>
<td>1–2</td>
<td>Mild</td>
<td>2–3</td>
<td>2.8–3.5</td>
<td>5–6</td>
<td>1.8–2.3</td>
<td>Child’s C = 10–15 points</td>
</tr>
<tr>
<td>3–4</td>
<td>Major</td>
<td>&gt; 3</td>
<td>&lt; 2.8</td>
<td>&gt; 6</td>
<td>&gt; 2.3</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: CTP, Child–Turcotte–Pugh; INR, international
normalized ratio; PT, prothrombin time.

Model of End-Stage Liver Disease (MELD)
The score is obtained through the following biochemical
tests: bilirubin, INR, and creatinine. The result is directly
proportional to the risk of surgical complications, that is, the
higher the score, the greater the risk (→ Table 1). There is vari-
ability in the results of the studies performed to determine a
cutoff point; however, it has been seen that values equal to
or greater than 8 have a high postsurgical morbidity and
mortality. 28 In search of obtaining a more accurate score on
the severity of liver disease and surgical risk, from 2016, after
several studies, the MELD score included the serum sodium
level in its tests, as hyponatremia has been established as a
negative predictor in postoperative results in patients under-
going liver transplantation. 29

Evaluation of Preoperative Liver Disease
The increase in the incidence of patients with liver disease
has led to expanding the study of this pathology. Various
scales have been created to assess the degree of liver injury,
and determine the risk, complications and postsurgical
prognosis. 18 Although liver biopsy is the gold standard for
diagnosing liver impairment, it is an invasive test, differ-
cent clinical and laboratory parameters have been sought
which more accurately approximate the severity of the
disease. 24,30 These scales, in addition to being inexpensive
and easy to perform, must have a high sensitivity to identify
patients with cirrhosis either to rule out any surgical inter-
vention including elective ones or, if possible, to control risk
factors as evidenced by high morbidity and mortality. 27

Complications and Postsurgical Outcome in Patient
with Liver Disease
Postsurgical complications in the cirrhotic patient are related
to the extent of liver injury, comorbidities, type of surgical
procedure, and medical expertise. Out of these factors, the
degree of dysfunction of liver disease appears to be the factor
with the greatest impact on risk of mortality. 27 In the neuro-
surgical setting, a life-threatening complication is intracra-
nial hemorrhage. However, it is sometimes can be overlooked
due to the clinical similarities of neurologic deficits, which
can be caused by hepatic encephalopathy. The evacuation of

these hematomas represents 30.6% of neurosurgical proce-
dures in patients with cirrhosis. 11,12,19

Additionally, complications related to cirrhosis may be
associated with acquired hemostatic deficiency, since coag-
ulopathy can impair the hemostasis in these patients, with
resultant increase in morbidity and mortality. Faced with
incompetent hemostasis, the need for transfusion is the
most anticipated complication. 10,18,19,31–33 Liao et al 34 reported
greater blood loss and prolonged hospital stay in patients
who underwent lumbar instrumentation and had liver cir-
rhosis. Similarly, another study by Goel et al, which included
patients undergoing craniotomy for brain tumor, showed
that liver disease is a significant predictor of surgical mor-
bidity and mortality, with increased hospital stay due to
multiple causes such as coagulopathy, hepatic encephalop-
athy, pulmonary failure, poor wound healing, and immuno-
compromise. 18 This demonstrates the importance of knowing
the relationship between liver disease and risk of sponta-
neous intracranial hemorrhage while planning neurosurgical
interventions. 17,19,34–37

Because the complications of neurosurgical procedures in
patients with liver cirrhosis are caused by alterations in coag-
ulation, transfusion of fresh frozen plasma (FFP) has been
suggested. Additionally, administration of vitamin K to cor-
rect the value of prothrombin time as well as maintaining a
platelet level > 50,000 are recommended. 18–40 An uncontrolla-
ble variable that has an impact on the results of patients with
liver cirrhosis is the urgency with which surgical procedures
are required regardless of the type, since emergency surgery
always carries a greater risk of morbidity and mortality. In
these patients the risk can be two times higher than in the
general population. 27 It has been suggested to improve the
CTP score before surgical intervention in the cirrhotic patient
to reduce the impact on morbidity and mortality. However,
this optimization of liver function is not entirely practical,
considering that neurosurgical interventions for bleeding
intracranial is mostly an emergent management. 12

Conclusions
Advances in medicine for the management of patients with
liver disease have brought with them new challenges for
surgeons, due to the increase in the requirement for surgi-
cal procedures. This raises questions about which patients
should undergo surgery and which patients should not,
and how to measure severity of liver disease and how to
reduce postsurgical risks. Little is known about neurosuri-
gical procedures, and there is no consensus on the most
accurate scale for evaluating the severity of liver disease
and thus surgical risk in neurosurgical patients. This is of
vital importance in emergency settings where adequate
optimization may not be a choice. The frequently used CTP
and MELD scores, which determine the risk of morbidity
and mortality, aid in decision-making regarding risks asso-
ciated with a surgical procedure. This risk must be taken
based on the calculated risk-benefit ratio and adequate
patient information. It is necessary to control the possible complications of these patients, as well as the surgical risk, through the management of ascites, nutritional support, maintenance of albumin levels and, in case of bleeding, FFP transfusions and administration of vitamin K.

Conflict of Interest
None declared.

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