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Surgical Apgar score for predicting complications after hepatectomy for hepatocellular carcinoma

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ABSTRACT

Background: Surgical Apgar score (SAS) was recently proposed as a simple predictor of postoperative complications. A few studies have shown the utility of the SAS in some kinds of surgeries, but it has not been investigated in patients undergoing hepatectomy for hepatocellular carcinoma (HCC).

Methods: This study included 158 patients undergoing hepatectomy for HCC. The association between SAS and postoperative complications was examined. The patients had postoperative morbidities classified as Clavien–Dindo grade II or higher. Multivariate regression analysis was performed to identify independent factors that significantly influenced the development of postoperative complications.

Results: Postoperative complications developed in 28 (17.7%) of the 158 patients. The proportion of cases with complications was significantly inversely correlated with SAS (Spearman rank correlation 0.829). The SAS was significantly lower in cases with complications than those without complications (5.6 ± 1.3 points *versus* 6.6 ± 1.3 points, $P = 0.0004$). Comparisons between patients with and without complication showed that preoperative serum albumin level and operation time, as well as SAS, were associated with complications. Multivariate analysis revealed that postoperative complications significantly correlated with the SAS.

Conclusions: This study demonstrated the clinical utility of SAS in predicting the development of postoperative complications after hepatectomy for HCC.

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Introduction

Hepatocellular carcinoma (HCC) is the most common primary malignancy of the liver, with a high prevalence in Asia and an increasing incidence in Western countries.[1,2] Liver resection is one of the curative therapeutic options for patients with HCC.[3,4] Recent advances in surgical techniques and perioperative management have significantly improved the safety of surgery for HCC, gradually decreasing mortality after liver resection.[5,6] The operative mortality of hepatectomy is reported to be 4.0% by the recently established National Clinical Database of Japan.[7] However, liver resection is still associated

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with posthepatectomy complications, especially in patients with underlying chronic liver disease[8,9]; the risk of postoperative complication remains high, with an incidence 20%-50%.[5,6,10] Postoperative complications may result in not only increased mortality but also longer hospital stays, increased cost of perioperative care, and compromised quality of life. Furthermore, it has been also reported that the development of postoperative complications are significantly associated with poor postoperative prognosis in patients with HCC.[11,12] This background demonstrates the importance of predicting and treating postoperative complications. In this regard, early identification of patients at high risk of postoperative complications would be a promising strategy. Several scoring models have been developed, including Physiologic and Operative Severity Score for the Enumeration of Mortality,[13] National Surgical Quality Improvement Program,[14,15] and Estimation of Physiologic Ability and Surgical Stress.[16] However, these scoring models require complex calculations using numerous perioperative variables not readily available at bedside, suggesting that the scoring models are inconvenient. In 2007, Gawande *et al.*[17] proposed a new scoring model, a 10-point surgical Apgar score (SAS) based on three intraoperative parameters: estimated blood loss, lowest intraoperative mean arterial pressure, and lowest intraoperative heart rate, which reflect intraoperative hemodynamic stability. Similar to the widely used obstetrical Apgar score developed by Virginia Apgar in 1953,[18] the SAS was intended to be used to predict patient outcomes immediately after surgery. Thus, the SAS is easy to calculate, and its components are based on only three variables easily accessible at bedside. Since the report by Gawande *et al.*,[17] the utility of the SAS for predicting postoperative complications has been validated in a few different types of surgeries.[19-23] In addition, the World Health Organization recommends using the SAS in their 2009 Guidelines for Safe Surgery.[24] However, to the best of our knowledge, the utility of the SAS for predicting postoperative complications has not been investigated in hepatectomy for HCC.

In the present study, we investigated whether the SAS can effectively predict postoperative complications in HCC patients undergoing hepatectomy. This is the first study to apply the SAS to patients undergoing hepatectomy for HCC.

Methods

This study included 158 consecutive patients (127 males, 31 females; mean age 70 ± 9 years) with HCC, who had undergone curative hepatic resection in the Department of Surgery at Toyonaka Municipal Hospital between January 2009 and December 2016. Clinicopathological data were gathered retrospectively from available hospital records, including estimated blood loss, lowest mean arterial pressure, and lowest heart rate to calculate the SAS (Table 1).[17] The surgical procedure was selected based on the extent of the tumor and residual liver function. Curative resection was defined as the complete removal of all macroscopically evident tumors. All patients without impaired hemostatic function underwent preoperative epidural catheter placement and patient-controlled epidural anesthesia. During the operation, general anesthesia was administered with inhalation anesthetics, and in cases with epidural catheter placement, epidural anesthesia was also used. After the operation, patients were managed in the intensive care unit until hemodynamic and respiratory stability were achieved. We defined postoperative complications as any complication rated ≥ grade II in the Clavien–Dindo classification system.[25] On the basis of extensive dialog with the Human Ethics Review Committee of Toyonaka Municipal Hospital, approval for an opt-out consent method was given. The study received ethical approval for the use of an opt-out methodology, and the participation of the patients was obtained through the opt-out methodology (Certificate Number 2017-04-03).

Data were expressed as mean ± standard deviation. Differences between groups were assessed by the chi-squared test, Fisher's exact test, or Mann–Whitney U test. Logistic regression analysis was performed for the selection of significant variables. The Spearman rank correlation test was used to test for correlations between pairs of numerical variables. The predictive value was assessed by calculating the area under the receiver–operator characteristic curve (AUC). The value of AUC was evaluated as described previously: from 0.5 (no discrimination) to 1.0 (perfect discrimination), a value of 0.7-0.8 was considered as reasonable, and a value over 0.8 was designated as good.[26,27] Statistical analyses were performed using StatView, version 5.0 (SAS Institute Inc, Cary, NC). A P-value < 0.05 was considered significant.

Results

Incidence of postoperative complications

The clinicopathological characteristics of the 158 patients are summarized in Table 2: 148 (93.7%) patients were categorized as A by the Child–Pugh classification, and 67 (42.4%) had histologically cirrhotic liver in noncancerous lesion. The maximum tumor size was 3.5 ± 2.6 cm. Multiple tumors and tumor thrombus were found in 16/158 (10.1%) and 39/158 (24.7%) cases, respectively. The operation time was 238 ± 111 min, and the resected liver volume was 209 ± 306 g. Anatomical and nonanatomical resections were performed in 67 (42.4%) and 91 (57.6%) patients, respectively. Postoperative complications rated as grade II or higher by the Clavien–Dindo classification occurred in 28 cases (17.7%; Table 3). The most frequent complication was pleural effusion and/or ascites (10/158, 6.3%), followed by cardiopulmonary events (5/158, 3.2%) and bile leakage (4/158, 2.5%). Operative mortality was observed in two patients (1.3%). In one case, the mortality was due to pneumonia, and the case was included in cardiopulmonary events in Table 3. The cause of the morality in the other case was liver failure, which was derived from postoperative portal vein thrombosis. One case with liver failure is shown in Table 3.

SAS for predicting postoperative complications

The distribution of the SAS in all cases is shown in Figure 1. The mean and median SAS for all patients was 6.5 and 7.0 points, respectively, with a standard deviation of 1.3 points. The proportion of cases with postoperative complications is

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