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Predictive factors for early failure of transarterial embolization in blunt hepatic injury patients

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AIM: To evaluate the early success of transarterial embolization (TAE) in patients with traumatic liver haemorrhage and to determine independent factors for its failure.

MATERIALS AND METHODS: From January 2009 to December 2012, TAE was performed in 48 patients for traumatic liver haemorrhage. Their medical charts were reviewed for demographic information, pre-TAE vital signs and laboratory data, injury grade, type of contrast medium extravasation (CME) at CT, angiography findings, and early failure. "Early failure" was defined as the need for repeated TAE or a laparotomy for hepatic haemorrhage within 4 days after TAE. Variables were compared between the early success and early failure groups. Variables with univariate significance were also analysed using multivariate logistic regression for predictors of early failure.

RESULTS: Among 48 liver TAE cases, nine (18.8%) were early failures due to liver haemorrhage. Early failure was associated with injury grade ($p = 0.039$), major liver injury (grades 4 and 5; $p = 0.007$), multiple CMEs at angiography ($p = 0.031$), incomplete TAE ($p = 0.002$), and elevated heart rate ($p = 0.026$). Incomplete embolization (OR = 8; $p = 0.042$), and heart rate >110 beats/min (bpm; OR = 8; $p = 0.05$) were independent factors for early failure of TAE in the group with major liver injuries.

CONCLUSION: Major hepatic injury is an important factor in early failure. Patients with a heart rate >110 bpm and incomplete embolization in the major injury group have an increased rate of early failure. The success rate of proximal TAE was comparable to that of the more time-consuming, superselective, distal TAE.

Introduction

The liver is one of the most frequently injured organs during blunt abdominal trauma.[1] In recent years, non-operative management has been increasingly used as the treatment of choice for haemodynamically stable patients with blunt hepatic injury.[2,3] However, contrast-enhanced

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CT is usually required to evaluate the severity of hepatic injury before arranging suitable non-operative management; CT is also a valuable tool for the detection of other associated organ injuries.[3–5]

Contrast medium extravasation (CME) from an injured liver, detected at CT, indicates active bleeding.[6,7] Using CT, CME can be classified into three types according to the patterns proposed by Fang et al. (2000).[4] Hepatic injuries with types I and II CME should be treated with emergency laparotomies, whereas injuries with type III CME have a high probability of successful non-operative treatment.[4]

Transarterial embolization (TAE) is used increasingly frequently as a non-operative technique to treat patients with active hepatic bleeding. TAE can be used regardless of whether a patient is haemodynamically stable on a case-by-case basis, unless there is catastrophic collapse, because of its effectiveness and low incidence of complications (reported to be 0–7%).[5,8–10] However, not every haemodynamically stable patient with hepatic haemorrhage shows complete cessation of bleeding following TAE. The early failure rate of TAE for hepatic bleeding is approximately 13–20%.[5,8–10] The clinical data and medical images of patients who underwent TAE for traumatic hepatic haemorrhage were analysed with the aim of improving the success rate of TAE in these patients.

Materials and methods

The institutional review board approved this retrospective study and informed consent was waived. In total, 73 patients who underwent emergency TAE for blunt liver trauma at Chang Gung Memorial Hospital from January 2009 to December 2012 were identified by searching the radiology information database. All of the medical charts were reviewed retrospectively by one radiologist. Abdominal CT and angiography images were reviewed and recorded by two radiologists who were blind to the final outcome. Discordances in image interpretation between the two radiologists were resolved in consensus in a joint review with an additional radiologist. Patients with blunt traumatic liver injury who had liver CME detected at both CT and angiography were included. Patients were excluded who had had primary TAE at other hospitals before being transferred to Chang Gung Memorial Hospital, who had undergone surgeries at Chang Gung Memorial Hospital prior to angiography, and who died before TAE was completed successfully. The exclusion algorithm for patients undergoing emergency TAE is shown in Fig 1.

After initial evaluation and resuscitation at the emergency department, patients with stable haemodynamic status underwent contrast-enhanced CT, ranging from the upper abdomen to the pelvis. Several patients who underwent abdominal CT at an outside hospital were also included. These patients did not undergo another abdominal CT in the emergency department if the image quality was acceptable. The CT images during the portovenous phase were reviewed and the arterial phase CT images were also referred to if these were available. Twelve experienced radiologists worked shifts at the emergency radiology division. If there was obvious CME from the hepatic artery, the target vessel would be embolized. The choice of embolic agents was at the discretion of the radiologist and included gelfoam suspension and/or microcoils. The endpoint of embolization was stagnant flow and cessation of CME from the target vessel on completion angiography.

Seven patients were excluded because they did not apparently suffer traumatic liver injury. Nine of the remaining 66 patients were excluded because their CT was not available for review, or the CT images did not show obvious CME from a liver injury. Although angiography was performed in the remaining 57 patients, nine patients were excluded from the analysis. Of the nine excluded patients, two did not have obvious CME on liver angiography, one had undergone TAE at another hospital before being transferred to the emergency department, five had undergone laparotomies prior to angiography, and one died before successful TAE was achieved. Finally, 48 patients (30 males and 18 females) with a mean age of 31 $\pm$ 13.99 years (range 8–64 years) who underwent TAE for blunt hepatic injury were included in the study. Their medical charts were reviewed for trauma mechanisms, pre-TAE vital signs, pre-TAE laboratory data, and early failure of TAE. The vital signs included heart rate and systolic blood pressure (SBP). Laboratory data included haemoglobin, international normalized ratio (INR), platelet count, glutamate oxaloacetate transaminase (GOT), and glutamate–pyruvate transaminase (GPT).

Abdominal CT images were reviewed for the severity of hepatic injury according to the liver injury scale revised by the American Association for the Surgery of Trauma (AAST) in 1994.[11] Liver CME at CT was classified into three types according to its location and characteristics: type I showed pooling of the contrast medium in the peritoneal cavity; type II simultaneously showed haemoperitoneum and pooling of the contrast medium in the liver parenchyma; and type III showed only intraparenchymal pooling of the contrast medium.[4]

Regarding angiography findings, the pattern of angiographic CME was categorized into single and multiple origins (indicating more than one site of bleeding; Fig 2). To determine the level of embolization at the hepatic arteries, the artery was divided into regions according to the arterial site where the catheter tip was engaged for embolization: proper hepatic artery, lobar hepatic artery, divisional hepatic artery, and segmental hepatic artery. The result was considered to be "incomplete embolization" if the final angiography revealed any CME or arterial blush (Fig 3). Probable causes of incomplete embolization were recorded after reviewing the angiography results. "Early failure" of TAE was defined as the need for repeated TAE or a laparotomy for intractable hepatic haemorrhage within 4 days from the first TAE.

Variables were compared between the early failure and early success groups of TAE. Continuous data were analysed using the Mann–Whitney *U*-test, and optimal cut-off values were determined by receiver operating characteristic (ROC) curve analysis. Categorical data were analysed using the χ^2