Hepatic Angioembolization in Trauma Patients: Indications and Complications.

Timothy S. Misselbeck
Lehigh Valley Health Network, Timothy.Misselbeck@lvhn.org

Erik J. Teicher MD
Lehigh Valley Health Network

Mark D. Cipolle MD, PhD, FACS

Michael D. Pasquale MD, FACS, FCCM
Lehigh Valley Health Network, michael.pasquale@lvhn.org

Kamalesh T. Shah MD
Lehigh Valley Health Network, Kamalesh.Shah@lvhn.org

See next page for additional authors

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Hepatic Angioembolization in Trauma Patients: Indications and Complications

Timothy S. Misselbeck, MD, Erik J. Teicher, MD, Mark D. Cipolle, MD, PhD, Michael D. Pasquale, MD, Kamalesh T. Shah, MD, Dale A. Dangleben, MD, and Michael M. Badellino, MD

Background: Hepatic angiography (HA) and hepatic angioembolization (HAE) are increasingly used to diagnose and treat intrahepatic arterial injuries. This study was performed to review indications, outcomes, and complications of HA/HAE in blunt trauma patients who underwent HAE as adjunct management of hepatic injury.

Methods: A retrospective review of consecutive cases of HA/HAE at a Level I trauma center during an 8-year period. Data include demographics, physiologic condition, liver injury grade, HA/HAE indications, outcomes, morbidity, and mortality.

Results: Seventy-nine patients underwent diagnostic HA; 31 (39%) had subsequent HAE. Fifty-eight hemodynamically stable patients had computerized axial tomographic (CT) scan followed by HA. HA was performed for contrast blush on CT in 30 (52%) of 58 patients, high-grade liver injury in 4 (7%), subsequent hemodynamic instability in 15 (27%), and angiography planned for other purpose in 9 (17%). HA confirmed arterial injury and led to HAE in 50% of patients with contrast blush on CT or high-grade liver injury. HA was negative when performed for hemodynamic instability or for other primary purposes. Twenty-one hemodynamically unstable patients underwent emergent laparotomy followed by postoperative HA with 11 (50%) requiring HAE. Overall mortality in HAE group was 16%, and liver-related morbidity was 29% usually presenting as gallbladder or liver necrosis.

Conclusion: HA/HAE should be used when CT scan suggests associated intrahepatic arterial or high-grade injury in the management of hepatic injuries and should also be considered after laparotomy and perihepatic packing to control inaccessible intrahepatic hemorrhage. Mortality related to HAE is uncommon, but morbidity occurs frequently.

Key Words: Hepatic angioembolization, Hepatic angiography, Trauma, Parenchymal necrosis, Gallbladder ischemia.

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From the Division of Trauma/Surgical Critical Care (T.S.M., E.J.T., M.D.P., K.T.S., D.A.D., M.M.B.), Department of Surgery, Lehigh Valley Health Network, Allentown, Pennsylvania; and Division of Trauma/Surgical Critical Care (M.D.C.), Department of Surgery, Christiana Care Health System, Newark, Delaware.
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Address for reprints: Michael M. Badellino, MD, Department of Surgery, Lehigh Valley Health Network, Cedar Crest & I-78, PO Box 689, Allentown, PA 18105-1556; email: sally.lutz@lvh.com.

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Nonoperative management of blunt hepatic injuries has become the treatment of choice in the hemodynamically stable trauma patient, with recent clinical series reporting success rates of >90%.[1–5] Even patients with high-grade liver injuries can be successfully managed without operation.[6] The benefits of nonoperative treatment include decreases in overall mortality, abdominal complications, and transfusion requirements when compared with surgical management.[1–4] Indeed, the evolution to nonoperative or conservative management of even complex hepatic wounds with associated vascular injuries is supported by a far more rational understanding of anatomy and physiology than that proposed during the era of aggressive operative management.[7]

The progression toward nonoperative management of hepatic injuries has been assisted by the development of more sensitive high-speed computerized axial tomographic (CT) scanners and advances in critical care.[8,9] Another innovation used in both operative and nonoperative management of these injuries involves the use of angiography and angioembolization techniques. Hepatic angiography (HA) has been increasingly used to diagnose intrahepatic arterial injuries, and hepatic angioembolization (HAE) has become an important interventional adjunct in the treatment of these injuries.[10,11]

Although nonoperative management is an appropriate treatment choice in hemodynamically stable patients, operative exploration is still indicated for the hemodynamically unstable patient. Even after resuscitative laparotomy, postoperative HA has been shown to be useful by allowing embolization to control arterial bleeding in inaccessible areas deep in the liver parenchyma.[12] Recently, there have been reports of HAE being used before or to obviate surgery in transient responders.[13,14]

The purpose of this study was to review the indications, outcomes, and complications of HA and HAE in a series of predominantly blunt trauma patients who underwent HAE as an adjunct to the management of hepatic injury.

PATIENTS AND METHODS

A retrospective review of prospectively collected data during an 8-year period from 1997 to 2005 at a Level I trauma center was performed on all patients who sustained liver injuries. Data were collected on patients who underwent HA and included demographics, presenting physiologic condition, hepatic injury grade, transfusion requirements, and hemodynamic parameters within the first 24 hours, indications for and results of HA or HAE, liver-related morbidity, and

mortality. All patients were evaluated and resuscitated according to standard trauma (advanced trauma life support) protocols. Patients were classified as hemodynamically stable at admission if systolic blood pressure was >90 mm Hg and intravenous fluid requirements did not exceed 2 L. Helical CT scans with 3-mm axial images were performed after the administration of intravenous contrast. Hepatic injuries were graded real time by a board certified radiologist using the American Association for the Surgery of Trauma Organ Injury Scaling Committee.[15] Radiology reports were reviewed for documentation of intrahepatic vascular injury as evidenced by active extravasation of intravenous (i.v.) contrast. Indications to perform angiography were determined by internal protocol and/or attending trauma surgeon preferences. Mortality and morbidity were recorded and classified as liver-related or nonliver-related. Data were analyzed by Pearson χ^2 analysis, with $p < 0.05$ considered significant.

RESULTS

During the 8-year study period, 707 patients with documented liver injury were evaluated at our trauma center. Seventy-nine consecutive patients with hepatic injury underwent HA; demographics showed that 60% were men and 40% were women, with a mean age of 32.6 years (range, 4–83 years). Subsequent angioembolization by gel-foam embolization or intraarterial coiling was necessary in 31 (39%) of these patients.

Fifty-eight patients presented with stable hemodynamics and had CT scan performed during initial evaluation. More than 80% of these patients had suffered an American Association for the Surgery of Trauma Organ Injury Scaling grade III or greater hepatic injury (Fig. 1). Ninety-six percent of patients had sustained blunt trauma. Indications for angiography in hemodynamically stable patients included active extravasation of i.v. contrast on CT scan in 30 (57%) of 58 patients, an episode of hypotension or a decrease in hemoglobin during nonoperative management in 15 (26%) of 58 patients, high-grade liver injury alone in 4 (7%) of 58 patients, or another primary reason for an angiogram in 9 (15%) of 58 patients (Fig. 2). Hepatic arterial injuries were confirmed in 20 patients (34%), and they underwent subsequent embolization. Of those patients who were hemodynamically stable on presentation and displayed active extravasation of contrast, 60% required embolization. Pearson χ^2 analysis demonstrates that patients with active extravasation of i.v. contrast on CT scan have a 20 times higher incidence of requiring embolization than those who do not show active extravasation ($p = 0.0001$).

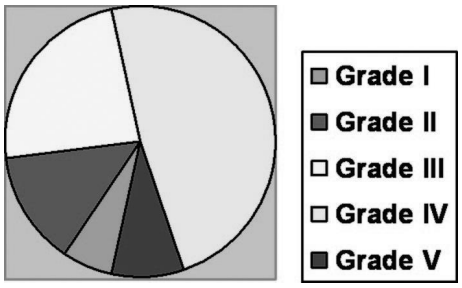


Figure 1. Severity of liver injuries in patients who underwent hepatic angiogram.

Twenty-one (26%) of 79 patients presented with hemodynamic instability and underwent immediate resuscitative laparotomy followed by postoperative angiography. Eleven (52%) of these 21 patients had evidence of ongoing hepatic bleeding that required embolization (Fig. 3).

Nine patients (11%) developed liver-related complications after embolization. Liver-related morbidity was defined as hepatic parenchymal necrosis (6 of 9), gallbladder ischemia or necrosis (6 of 9), bile leak (1 of 9), abscess (4 of 9), or liver failure (1 of 9) (Table 1). Six patients underwent operative debridement of necrotic liver parenchyma. Three of these patients had an open abdomen and were undergoing serial washout procedures when necrosis was discovered. The other three patients had necrosis diagnosed by imaging. These patients were treated with operative debridement. Bile leaks and abscesses were treated successfully by percutaneous drainage. Gallbladder ischemia, which occurred in 66% of patients after embolization, required cholecystectomy. Although there were four (5%) mortalities in the embolized group, only one was directly related to liver failure. Other mortalities were due to severe head injuries or cardiac failure. There were no deaths from exsanguination.

DISCUSSION

The initial care of a patient with hepatic injury must be dictated by presenting physiologic condition and associated injuries. Hemodynamically unstable patients should undergo immediate operative exploration with the goal being direct control of hepatic bleeding by portal clamping, perihepatic packing, direct repair, or vascular isolation. A nonoperative management strategy is preferable in the hemodynamically stable patient with known or suspected liver injury.[1–5] HA has emerged as an important adjunct in the treatment of traumatic liver injuries with an efficacy well documented in several clinical series.[11–13,16,17] Specific subsets of patients who would most benefit from angiography and embolization have not been clearly identified.

This study was designed to examine the indications for HA in a group of primarily blunt trauma victims at a busy Level I trauma center and identify patients who require embolization. Overall, 40% of angiographies resulted in subsequent therapeutic embolization. This finding contrasts with those of others who report overall therapeutic embolization rates of 70% to 100% among all angiographies performed.[12,13,16–18] The low rate of therapeutic embolization in this study is probably due to patient selection, when compared with previous reports, angiography was performed in a large percentage of patients who did not have CT evidence of contrast extravasation.

Over the years, the multidetector CT scan (MDCT) enhanced with intravenous contrast has become the imaging modality of choice to evaluate the hemodynamically stable trauma patient with suspected liver injuries.[19] The MDCT scan allows for rapid and accurate diagnosis of potential injuries. Before the advent of the MDCT, conventional CT

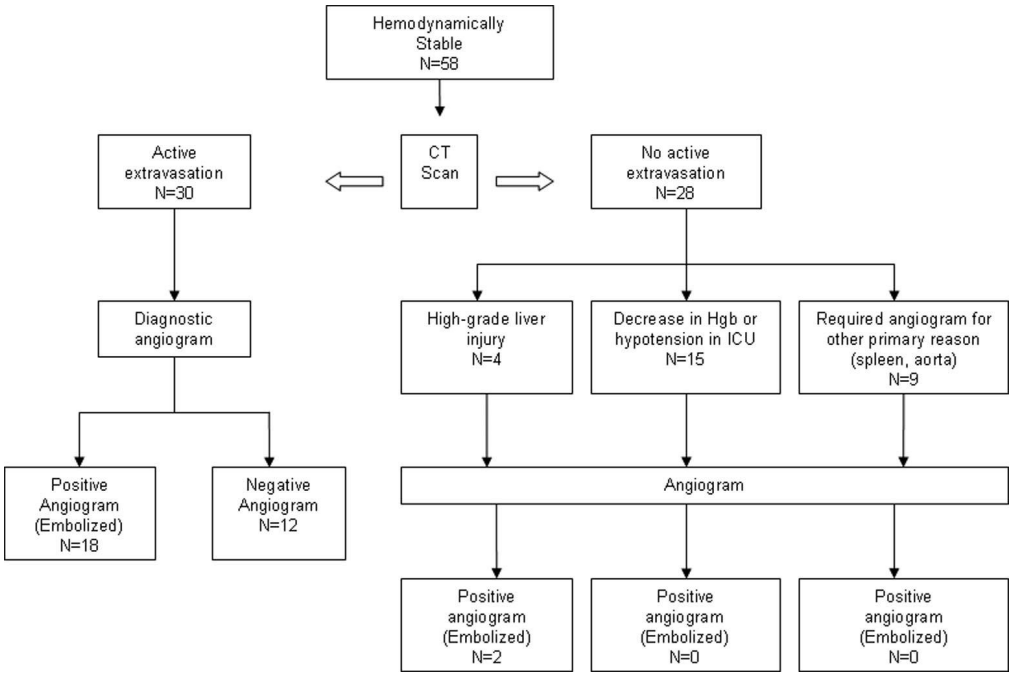
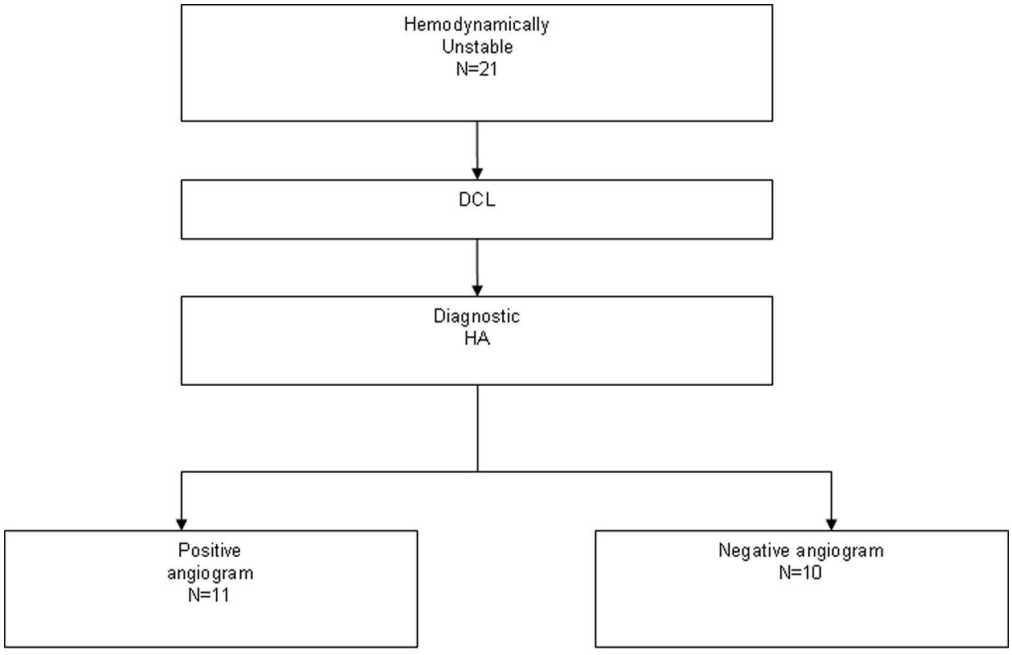


Figure 2. Patients who underwent hepatic angiogram presenting as unstable on admission.



DCL = damage control laparotomy; HA = hepatic angiography.

Figure 3. Patients who underwent hepatic angiogram presenting as stable on admission.

scans were used, which were of lesser quality. We have noticed no changes in our practice regarding CT imaging modality. Previous to the widespread use of convenient CT scanning, the Focused Assessment with Sonography examination was used more often in hemodynamically stable patients to rule out intra-abdominal injuries; however, this resulted in a significant number of missed injuries.[20] MDCT is superior in that it can detect even small quantities of blood and allows for grading of hepatic injuries, which may be useful in predicting the need for subsequent interventions.[8] In our series, all stable patients who required HA first underwent MDCT scanning. The availability of MDCT plays a less significant role in the unstable trauma patient because the decision to proceed with angiography in these patients is often based on operative findings.

TABLE 1. Morbidity in Patients Who Underwent Hepatic Angioembolization (N = 9)

Patient	Grade	Indication for HA	Type of HAE	Complication	Outcome	Intervention
1	IV	Active extravasation on CT	Right hepatic proximal: coils, GF	Hepatic necrosis, bile leak	Alive	Debridement, PD, ligation of bile ducts
2	IV	Active extravasation on CT	Right hepatic distal: GF	Hepatic necrosis, abscess, GB	Alive	Debridement, PD, CCY
3	III	Active extravasation on CT	Common hepatic: GF	Hepatic failure	Death	Supportive care
4	III	S/p DCL	Right, left hepatic branches: GF	Abscess	Alive	PD
5	V	S/p DCL	Right hepatic proximal: GF	Hepatic necrosis, abscess, GB	Alive	Debridement, CCY, PD
6	I	S/p DCL	Right hepatic branch: GF	Hepatic necrosis, sepsis, GB	Alive	Debridement, CCY
7	IV	Active extravasation on CT	Right hepatic branch: GF	GB	Alive	CCY
8	IV	S/p DCL	Right hepatic: coils	Hepatic necrosis, GB	Alive	Debridement, CCY
9	IV	Active extravasation on CT	Right, left hepatic branches: GF	Hepatic necrosis, abscess, GB	Alive	Debridement, CCY, PD

CCY, operative cholecystectomy; S/p DCL, status post damage control laparotomy; GB, gallbladder necrosis; GF, gel-foam; PD, percutaneous drainage.

Few would argue that hemodynamically unstable patients with suspected liver injuries should undergo operative exploration. Current surgical consensus supports the use of resuscitative or staged surgical techniques including abbreviated surgery, perihepatic packing, and temporary closure. This study confirms the finding of several authors who have advocated postoperative angiography and embolization may be useful adjuncts in this setting.[12,18,21] Fifty-two percent (11 of 21) of hemodynamically unstable patients who had undergone staged laparotomy showed continued postoperative intrahepatic hemorrhage on angiography and required embolization, suggesting that, despite successful operative packing, hepatic arterial bleeding can continue, especially in the deep liver parenchyma, which is difficult and potentially dangerous to approach surgically.[6]

HA was performed on all patients who demonstrated active extravasation of contrast at admission CT. Of these patients, 60% (18 of 30) had evidence of arterial injury on angiography and required therapeutic angioembolization, which is consistent with current literature.[8] Conversely, only 7% (2 of 28) who did not exhibit extravasation of contrast on CT scan required embolization. Therefore, those patients with active extravasation of contrast on CT imaging are 20 times more likely to require embolization than those without contrast extravasation.

Hepatic vascular injuries are more likely in high-grade injuries, and some authors propose performing angiography on all of these patients.[10,22] In this series, HA was performed in four hemodynamically stable patients with grades IV or V liver injuries who did not exhibit contrast extravasation on CT scan. Angiography detected arterial bleeding in two (50%) of these patients who underwent subsequent embolization. Because of the small sample size, no definitive recommendation regarding angiography in patients with high-grade liver injury alone can be made, but clearly this group deserves further study.

A significant observation was made in the group of 15 patients who experienced a period of hypotension subsequent to resuscitation or drop in hemoglobin during the initial 36 hours of nonoperative management. Although active intrahepatic bleeding had not been detected on CT scan in these patients at admission, angiography was performed and embolization was not required.

Nine hemodynamically stable patients without evidence of contrast extravasation on CT scan underwent angiography to evaluate other conditions such as active splenic bleeding or evaluation of thoracic hematoma. Concurrent HA was negative in all these patients.

The overall mortality rate in the 31 patients who underwent embolization was 16%. Importantly, only one death was directly related to liver failure. This death occurred in an elderly woman who had a nonselective embolization of the proper hepatic artery. Other causes of death were severe head injury or cardiac failure. There were no deaths from exsanguination.

Among 31 patients who underwent hepatic embolization, nine patients (29%) experienced liver-related complications. This is consistent with previous reports.[17] Six patients required operative debridement of necrotic liver parenchyma, three of which already had an open abdomen and were undergoing serial washout procedures when the necrosis was discovered. The remaining three patients had necrosis diagnosed by clinically guided imaging. Bile leaks and abscesses were all successfully treated nonoperatively by percutaneous drainage.

Gallbladder ischemia or necrosis occurred in six patients and accounted for a large percentage of overall morbidity, which is consistent with other reports.[5,10,23] All the patients in the present series who developed gallbladder ischemia had selective right hepatic artery embolization performed, which suggests that super-selective embolization techniques may be warranted. The best way to prevent this complication may be avoided by selective embolization of the right hepatic arterial tree distal to the takeoff of the cystic artery if possible. With this knowledge, surveillance of gallbladder viability after embolization is important.

CONCLUSION

HA and embolization are useful adjuncts in the management of hepatic injuries. Angiography is useful in documenting intrahepatic vascular injury in hemodynamically stable patients with high-grade liver injury or when intrahepatic bleeding is suggested by contrast extravasation at admission CT scan. These patients are 20 times more likely to

require embolization procedures than those patients who did not have contrast extravasation on CT imaging. More than 50% of these patients require subsequent therapeutic HAE. Similar efficacy can be expected even in patients who present hemodynamically unstable and require urgent laparotomy with perihepatic packing. In these cases, angiography and embolization can be used to control deep, inaccessible bleeding. The application of angiography, based solely on a single episode of hypotension during a period of nonoperative management, seems unwarranted. Mortality related to hepatic embolization is uncommon. More frequent is the morbidity resulting from embolization, which usually presents as gallbladder ischemia, hepatic parenchymal necrosis, abscess, or biloma, requiring operative interventions such as cholecystectomy or debridement, or nonoperative management with percutaneous interventions.

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