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Journal of the Chinese Medical Association 74 (2011) 341−344

www.jcma-online.com

Original Article

Spleen artery embolization increases the success of nonoperative management following blunt splenic injury

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Received January 12, 2011; accepted April 20, 2011

Abstract

Background: Spleen artery embolization (SAE) may increase the success rate of nonoperative management (NOM). The present study investigated the clinical outcome after the installation of SAE in the management of blunt splenic injury.
Methods: A retrospective review of hospital records was performed to enroll patients with blunt injury of the spleen. Demographic data and information about the injury severity score, organ injury scale, hospitalization days, management and final outcomes were evaluated. Patients were separated into early and late groups according to the year that SAE was selectively used (2003−2004 and 2005−2008).
Results: Six of eleven (55%) patients in the early group were successfully managed without surgery for blunt splenic injury, whereas all of the 38 patients (100%) in the late group were successfully managed without surgery. Eleven patients (11 of 38; 28.9%) received SAE in the late group. The rate of NOM increased from 55% in the early group to 100% in the late group ($p < 0.001$). Both early and late groups had similar injury severity score, length of hospitalization, blood transfusion, and complications, and there was no mortality.
Conclusion: Performance of SAE for the patients with blunt splenic injury could increase the successful rate of NOM significantly and safely. An algorithm including the angioembolization might be beneficial in the management of patients with blunt spleen trauma.

Keywords: Angioembolization; Nonoperative management; Spleen trauma

1. Introduction

During the last decade, nonoperative management (NOM) has become the preferred treatment for hemodynamically stable patients with blunt splenic injury.[1,2] Advancements in computed tomography (CT) technology have improved our ability to define the degree of splenic injury more accurately to identify patients who are more suitable for NOM.[3] Splenic injury with organ injury scale of above Grade 3 and findings on CT, including active contrast extravasation, traumatic pseudoaneurysm, or a large hemoperitoneum, have been associated with a greater likelihood for the failure of NOM.[4−7] In recent years, spleen artery embolization (SAE) has been advocated and shown to increase the success rate and decrease mortality for NOM of spleen injury.[3−5] Although there are controversies, contrast blushes or pseudoaneurysm found on CT images have been proposed as indications for spleen interventions including SAE.[8,9] Compared with splenecotmy, NOM eludes the dysregulation of patients' immune response secondary to operative trauma and avoids the postoperative complications.[10]

In our previous report, we designed two algorithms for the management of patients with blunt abdominal trauma (BAT), either with stable or unstable hemodynamics, by meticulously using sonogram screening and CT scan. We found that, by following those algorithms, the need for nontherapeutic laparotomy decreased in patients with BAT.[11] Since then, most of

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1726-4901/$ - see front matter
doi:10.1016/j.jcma.2011.06.005

our patients with BAT have been managed by following the algorithms. The algorithms were verified further in a retrospective study for the management of patients with spleen injury.[12] However, the algorithms may require revision because of the increasing use of SAE. In the present study, we reviewed our experience in the management of spleen injury and compared the outcomes between periods of before and after installation of SAE.

2. Methods

The study was approved by institutional review board and conducted at a university medical center. Records for adult patients (age $\geq$ 18 years) with blunt injury of the spleen were reviewed retrospectively for the period of 5 years (2003 to 2008). Enrolled patients were managed primarily in our hospital. Patients, who were suspected to have blunt abdominal injury, were initially assayed by abdominal ultrasound and managed according to the algorithms described in our previous reports.[11,12] Unstable patients, whose ultrasound images showed the presence of intraperitoneal fluid, were directed to operation room for exploratory laparotomy; stable patients with the same findings on ultrasound images were the candidates for subsequent helical contrast-enhanced CT scan examination. From 2005, we performed SAE for spleen injury in selected patients. The SAE would be performed for patients if any sign of potentially ongoing bleeding (contrast brush or pseudoaneurysm formation) found on CT images. Patients who received nonoperative treatments, either with or without embolization, were admitted to the intensive care unit for at least 24 hours of observation before being transferred to ordinary ward. Data obtained from medical records included age, causes of injury, blood pressure on admission, initial management including NOM or operation, associated extra- and intra-abdominal injuries, injury severity scores (ISS), and outcomes. For the comparison between the era with or without SAE, patients were separated into 2 groups based on period of using SAE in selective patients, e.g. early group (from 2003 to 2004) and late group (from 2005 to 2008).

2.1. Statistical analysis

Categorical data were analyzed using the Chi square test. Continuous data were described as mean ± standard deviation, and were analyzed by Student *t* test. A *p* value of <0.05 was considered statistically significant.

3. Results

From January 2003 to December 2008, there were 49 patients with spleen injury enrolled in the present study. The major trauma mechanisms included 38 (80%) motor vehicle accidents and 8 falls (16%). Eleven patients were in the early group (2003−2004) and 38 patients in the late group (2005−2008). Five patients who received splenectomy were all in the early group, whereas 11 patients who received SAE were in the late group. None of the patients in the late group needed splenectomy. The demographical data are shown in Table 1. There was no significant discrepancy between these two groups regarding the gender, age, ISS, organ injury scale of spleen, presence of shock on admission, and transfusion amount. Four patients in early group and five patients in the late group were found to have an initial hypotension (SBP < 90 mmHg) on presentation at emergency room (ER). The four patients in the early group with initial hypotension were undergone splenectomy directly. The other one patient in the early group received splenectomy because of delayed hypovolemic shock after completion of CT scan in the ER. The five patients in the late group with initial hypotension received SAE and were then managed without surgery.

Six patients in the early group and 38 patients in the late group received NOM (55% *vs.* 100%; $p < 0.001$) (Table 2). There were 11 patients in the late group who received SAE (11 of 38; 28.9 %): one with Grade 3, nine with Grade 4, and one with Grade 5 spleen injury. There was no significant difference in the number of intensive care unit or hospitalization days between the early and late groups (Table 2). Five patients received splenectomy in the early group, whereas one of them had postoperative complication with pancreatitis. One of the SAE patients in the late group developed left pleural effusion. There was no mortality, and the complication rate was not different between early and late groups (Table 2). When comparing the patients with splenectomy with those with SAE, no significant discrepancy could be found regarding age, ISS, organ injury scale of spleen, presence of shock on admission, hospitalization days, or complications (Table 3).

Table 1
Demographic data of 49 patients with splenic injury before and after the installation of SAE

	Before SAE	After SAE	*p*
Patients (*n*)	11	38	
Sex (M/F)	(7/4)	(31/7)	0.237
Age	34.1 ± 16.6	32.5 ± 18.0	0.565
ISS	22.0 ± 13.0	14.0 ± 7.1	0.059
Spleen OIS ≥3	11 (100%)	28 (73.7%)	0.090
SBP <90 mmHg	4 (36.7%)	5 (13.2%)	0.179
Blood transfusion (mL)[a]	233.6 ± 280.6	132.1 ± 199.0	0.251

[a] Blood transfusion amount at emergency room.
F = female; ISS = injury severity scores; M = male; OIS = organ injury scale; SAE = spleen artery embolization; SBP = systolic blood pressure.

Table 2
The clinical outcomes of 49 patients with splenic injury before and after the installation of SAE

	Before SAE	After SAE	*p*
Patients (*n*)	11	38	
NOM (rate)	6 (55%)	38 (100%)	<0.001
ICU stay (d)	3.2 ± 2.6	2.5 ± 1.1	0.701
Hospital stay (d)	11.6 ± 8.2	10.4 ± 5.6	0.596
Complication	1(9%)	1 (2.6%)	0.402
SAE	0 (0%)	11 (28.9%)	

ICU = intensive care unit; NOM = nonoperative management; SAE = spleen artery embolization.

Table 3
Demographics and clinical outcomes in patients receiving operation or SAE

	OP	SAE	p
Patient (n)	5	11	
Age	29.0 ± 12.3	28.9 ± 18.2	0.415
Spleen OIS	4.2 ± 0.5	4.0 ± 0.5	0.421
SBP <90 mmHg	4 (80%)	5 (45.5%)	0.231
Hospital day	14.6 ± 11.2	12.1 ± 9.7	0.712
ICU days	4.2 ± 3.5	2.6 ± 1.1	0.165
Complications	1	1	0.542

ICU = intensive care unit; OIS = organ injury scale; OP = operation; SAE = spleen artery embolization; SBP = systolic blood pressure.

4. Discussion

This study shows that the performance of SAE for patients with spleen injury will result in a higher success rate of NOM. The success rate for NOM was 55% in the era during which SAE was not used and increased to 100% after performance of SAE as a therapeutic modality. The rate of splenectomy decreased whereas the use of SAE and the success of NOM increased over time. Although our study shows no significant discrepancy regarding complication, mortality, and hospitalization days between the era with or without using SAE, the study of Sabe et al[8] showed that using SAE could make an increase in overall splenic salvage rate, up to 97%, with a decline in mortality and fewer hospitalization days.

Although the grade of spleen injury was similar between early and late groups, or between operation and SAE patients, other reports have demonstrated a higher grade of splenic injuries among patients requiring SAE.[9,13] This suggests that the use of SAE, whether done initially or for those who are failing NOM, can reduce the need for operation. Although some controversy exists regarding the indication for SAE by injury grade of spleen, vascular blush or pseudoaneurysm on CT image requires aggressive attitude for SAE. Spleen injury above Grade 3 with large hemoperitoneum was used as an indication for SAE in another study.[8] These parameters have been demonstrated to be associated with an increased failure of NOM in a previous report.[6] Haan et al found a significant association with NOM failure and the presence of arteriovenous fistula but did not report increased failure rates with large hemoperitoneum or active contrast extravasation.[14] Another study proposed recently a new CT-based grading system in which active bleeding, arteriovenous fistula, pseudoaneurysm, and vascular injury are the main parameters used to determine the grade of splenic injury.[15]

In the present study, we did not have a strict protocol to follow for SAE; however, we performed this procedure in the case of contrast extravasation or pseudoaneurym found on CT images for patients with stable hemodynamics. Using these criteria, we have demonstrated a 100% success rate among patients selected for NOM. These results equal or surpass those of previous reports.[14,15] Although SAE adds to the cost of care initially, the benefits of an avoidance of operation will most likely offset this expense. Furthermore, the initial use of SAE may avoid some of the potential complications of hemodynamic instability that invariably occur if SAE is reserved only for those patients who are failing NOM. Our findings suggest that the use of SAE based on CT-defined parameters associated with ongoing bleeding was associated with a significantly improved success of NOM in patients with blunt splenic injury.

Higher grade of splenic injury or larger amount of hemoperitoenum have been published as contraindications to NOM.[7,16] Starnes et al concluded that Grade 4 to 5 injuries require operative intervention.[7] In our present study, there were 5 patients with Grade 4 to 5 injuries, who received SAE and were successfully managed without surgery. Patients with imaging findings of large hemoperitoneum are likely to have significant and severe splenic injury; however, hemoperitoneum alone is an indication for increased clinician alertness, but not a contraindication to NOM. In the present study, the degree of hemoperitoneum was not calculated from CT images; however, all patients in the late group were successfully managed nonoperatively after the selective use of the SAE, regardless of the amount of hemoperitoneum.

Hypotension on arrival is another concern. In the case of trauma, many factors may contribute to initial hypotension at the ER. Bee et al showed that hypotension alone was not a significant prognostic indicator of NOM failure.[17] In the present study, four patients in the early and five patients in the late group had initial hypotension; four received splenectomy in the early and five received NOM in the late group. Our studies indicated that hypotension, although necessitating careful clinical decision making, is not a contraindication for SAE.

We have previously reported that the use of diagnostic algorithms would achieve a more successful NOM rate and decrease nontherapeutic laparotomy. Patients with initial unstable hemodymamics could be resuscitated and subjected to subsequent NOM.[11] From the results of the present study, we find that the use of SAE will further increase the success of NOM. Besides for spleen injury, angioembolization can be used in the treatment of active bleeding from liver and kidney or pelvic injuries.

There are some limitations to this study. Foremost, this was a retrospective analysis that compared data over the span of 6 years. Thus, differences in outcomes could be multifactorial and might in part reflect the improvement in medical practice rather than the effects of SAE. The subjectivity of radiologists may affect the grading of spleen injuries, and the experience of radiologists performing SAE may affect the technical success. A well-coordinated team of trauma surgeon, radiologist, and anesthesiologist is mandatory for a success and safe SAE. Finally, our study population was relatively small; the NOM rate might be not altered dramatically, if more patients were enrolled.

In conclusion, although a prospective study may be needed, installation of SAE for patients with blunt splenic injury can increase the success of NOM significantly and safely. Initial assessments including the angioembolization will be beneficial in the management of patients with BAT.

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