J Korean Surg Soc 2011;80:56-60
DOI: 10.4174/jkss.2011.80.1.56

□ 원 저 □

Extension of Nonoperative Management on Spleen Injury with Judicious Selection and Embolization; 10 Years of Experience

Departments of Surgery and [1]Radiology, Konyang University Hospital, Daejeon, Korea

Tae-Young Koo, M.D., **Yu-Mi Ra,** M.D., **Sang Eok Lee,** M.D., **In Seok Choi,** M.D., **Dae Sung Yoon,** M.D., **Young Jun Jo,** M.D.[1], **Won Jun Choi,** M.D.

Purpose: We describe clinical outcomes of NOM on spleen injuries with judicious selection and embolization during the past 10 years.

Methods: From March 2000 to November 2009, 151 patients with splenic injury were included. Eighteen patients were excluded because of incomplete data. Patients' medical records were reviewed to examine admission demographics, laboratory results, radiologic findings as well as transfusion requirement, hospital stay, and ultimate outcomes.

Results: Twenty patients were chosen for non-operative management (NOM) after splenic embolization and 1/20 (5%) patient failed. There were 32 patients more than 55 years old (range, 55～87 years). Of these patients, 26 (81%) patients were chosen for NOM and 3 (11.5%) patients failed. According to OIS, 51 patients were grade 3; 26 patients, grade 4; and 6 patients, grade 5. Among grade 3, 49 (96%) were chosen for NOM with or without embolization and 1 (2%) patient failed; grade 4, 19 (73%) with NOM, 2 (7.6%) patients failed. Of all 133 patients with NOM or failed NOM (FNOM), there was 0 mortality in grade 3; 2, in grade 4; 2, in grade 5, excluding other causes of death. The mean ISS was significantly higher in the failed NOM group compared with successful NOM group (P=0.01). The group of failed NOM had a significantly higher mean OIS (P=0.00).

Conclusion: Aggressive but highly selective NOM on the base of clinicoradiologic parameters with the aid of angioembolization would result in a low failure rate and complication in the management of high grades (grade 3 or 4). **(J Korean Surg Soc 2011;80:56-60)**

Key Words: Spleen injury, Nonoperative management, Angioembolization

INTRODUCTION

The spleen is the most commonly injured abdominal organ during trauma. During the past two decades, the practical management of patients with an injured spleen has shifted from operative to nonoperative management (NOM) in hemodynamically stable cases.(*1,2*) The Absolute Indications for exploration are hemodynamic instability (a systolic blood pressure of <90 mmHg and a HR of > 120/minute) despite fluid resuscitation, suspicion of other injuries, continuous bleeding, and splenic hilar injury. The NOM of splenic injuries was first accepted by pediatric surgeons in the 1960s after it was realized that postsplectomy infection (OPSI) rates were extremely high. Subsequently, NOM became the standard treatment for low grade, isolated splenic injuries without signs of peritonitis in hemodynamically stable patients.

However, the inclusion criteria for NOM continue to evolve despite the fact that treatment failure rates have been reported to range from 15 to 40%.(*3,4*) However, it remains controversial as to whether older adults and those with a high grade injury should be managed nonoperatively.(*5,6*) Here, we describe the clinical outcomes of the

Correspondence to: Won Jun Choi, Department of Surgery, Konyang University Hospital, 685, Gasoowon-dong, Seo-gu, Daejeon 320-718, Korea. Tel: 042-600-8956, Fax: 042-543-8956, E-mail: cwj@kyuh.co.kr
Received July 29, 2010, Accepted December 7, 2010
This paper was presented at the 61th annual meeting of the Korean Surgical Society, November 11～13, COEX, Seoul, Korea.

NOM of spleen injury cases judiciously selected and which underwent embolization over a 10-year period. In addition, we discuss the extension of inclusion criteria for NOM for splenic injuries irrespective of age or grade.

METHODS

This retrospective review was performed on consecutive patients admitted with a traumatic splenic injury to the local emergency medical center (LEMC) of Konyang University Hospital over the 10-year period 2000 to 2009. Chart reviews were performed to obtain details of admission demographics, laboratory results, radiographic findings, transfusion requirements, patient management plans, hospital stays, and ultimate outcomes.

We defined patients treated by NOM as those that did not undergo an operation immediately (≤12 hours after admission). Successful NOM (SNOM) was defined as successful management and discharge, FNOM was defined as operative management due to NOM failure, an initial operation (iOP) (≤12 hours after admission), or a delayed operation (dOP) (>12 hours after admission). Operative treatments were splenectomy or splenorrhapy.

Angiographic evaluations and embolizations (with the cooperation of radiologists) were used during treatment periods in hemodynamically stable patients with a blush by computed tomography. Arteries for catheterization was accessed via the femoral artery and the embolization materials used were coils or gelfoam, as determined by the radiologist responsible. Injury severities were scored using the organ injury scale (OIS, 1994 revision), Glasgow coma scale (GCS), and Injury Severity Scores (ISS; ISS is an anatomical scoring system that provides an overall score for patients with multiple injuries). Each injury was assigned an abbreviated injury scale (AIS) and allocated to one of six body regions (head, face, chest, abdomen, the extremities (including the pelvis)). Only the highest AIS score assigned to a body region was used.

The scores of the three most severely injured body regions were squared and summed to produce the ISS score.(7) The iOP group was compared with the SNOM group in terms of clinicoradiographic characteristics. These two groups were compared after angioembolization to evaluating the efficiency of the procedure. Data are reported as means± SDs with 95% confidence intervals or as raw numbers or percentage. Analysis was performed using the independent samples t-test or the Chi-square test. Significance was accepted for P-values of <0.05, and SPSS Ver. 16 for Windows (Chicago, IL, USA) was used throughout.

RESULTS

A total of 151 patients were admitted to our emergency room with abdominal trauma, due to splenic injury by computed tomography or ultrasonography, during the study period. Eighteen patients who were not followed up completely because they were transferred to other hospitals during the course of management were excluded. Of the remaining 133 patients, most were male (69%) and motor vehicle collisions predominated (29%). Thirteen patients (9.7%, 13/133) required early laparotomy for splenic bleeding control with total splenectomy or splenorrhapy. Mean ISS was 22.9±1.3 and mean OIS of the spleen was 2.9±0.1 One-hundred and eighteen (88.7%, 118/133) patients fulfilled the criteria for NOM. SNOM occurred in 113 of 118 (95.8%) and FNOM in 5 (4.2%) patients. 20 patients were planned for NOM after splenic embolization and 1/20 (5%) patient failed.

There were 32 patients >55 years old (range, 55～87 years). Of these patients, 26 (81%) were underwent NOM and 3 (11.5%) patients failed. According to the OIS, 51 patients were of grade 3, 26 were of grade 4, and 6 were of grade 5. Among the 51 grade 3 patients, 49 (96%) underwent NOM with or without embolization and 1 (2%) patient failed; of the 26 grade 4 patients, 19 (73%) underwent NOM, and 2 (7.6%) failed. Of all 133 patients that underwent NOM or FNOM mortalities were; 0 for grade 3, 2 for grade 4, and 2 for grade 5 (after excluding other causes of death). Of the 5 FNOM patients, 4 patients underwent delayed splenectomy and survived. The remaining patient, who did not provide informed consent for surgery died. Table 1 summarizes the demographics and

Table 1. Patient demographics and relevant clinical data

	Number/Mean±SD (n=133)
Age (years)	37.8±1.9
Sex (M : F)	92 : 41
Above 55 years old	32/68.4±1.41
Below 15 years old	24/8.1±0.95
Mechanism	
Motor vehicle collision (MVC)	37
Pedestrian vs.MVC	18
Fall	36
Motorcycle collision	16
Bicycle collision	7
Violence	11
Other	8
Glasgow coma scale	
Alert	116
Drowsy	8
Stupor	6
Semicoma	3
Coma	0
Injury severity score	22.9±1.3
Organ injury scale (spleen)	2.9±0.1
Grade 1～2	50
Grade 3	51
Grade 4	26
Grade 5	6
Initial operation	13
Delayed operation	4
Splenectomy	15
Splenorrhapy	2
Overall nonoperative management (NOM)	118
Successful NOM	113
Failed NOM	5
Splenic angioembolization	22
NOM	20
Successful NOM	19
Failed NOM	1
Mortality	7
Cause of death	
Spleen injury	3
CNS injury	2
Lung injury	2

distribution of the study groups.

We also compared the clinical data of the operation group (OP-group) and the SNOM-group. Mean OIS (P=0.000) was significantly higher in the OP-group. However, no significant intergroup difference was found for transfusion requirements (P=0.059), we found that transfusion requirement was tendency of the correlation between two groups. Furthermore, no significant intergroup differences were found for age, ISS, hospital stay, initial systolic blood pressure, or initial heart rate (Table 2). Overall ISS and OIS scores were associated with FNOM. Mean ISS was found to be significantly higher in the FNOM group than in the NOM group (P=0.01) In addition, the FNOM group had a significantly higher mean OIS than the SNOM group (P=0.00) (Table 3).

We also compared the clinical data of members of the OP and SNOM groups that underwent angioembolization. No significant difference was found between the two in terms of age, ISS, GCS, OIS, hospital stay, transfusion requirement, initial blood pressure, or initial heart rate (P＞0.05)(Table 4).

Table 2. Comparison of the clinical data of the OP and SNOM groups

Variable	OP*-group (n=13)	SNOM† group (n=113)	P
Mean age	45.4±5.0	36.1±2.0	0.139
Above 55 years old	5	23	0.383
Injury severity scale	22.6±3.6	21.6±1.3	0.803
Glasgow coma scale			0.656
Organ injury scale	3.8±0.3	2.7±0.1	0.000
Hospital stay (day)	24.5±5.4	24.6±2.4	0.988
Transfusion (ml)	3,286.2±744.1	1,353.2±333.3	0.059
Initial systolic BP	100±10.1	107.7±2.2	0.280
Initial heart rate	90.2±4.8	92.9±2.3	0.695

*OP = operation; †SNOM = successful NOM.

Table 3. Comparison of the clinical data of the SNOM and FNOM groups

Variable	SNOM group (n=113)	FNOM* group (n=5)	P
Mean age	36.1±2.0	54.6±13.4	0.068
Above 55 years old	23	3	0.070
Injury severity scale	21.6±1.3	37.6±6.4	0.01
Glasgow coma scale			0.07
Organ injury scale	2.7±0.1	4.0±0.3	0.00
Hospital stay	24.6±2.4	10.6±5.3	0.22
Transfusion	1,353.2±333.3	3,920.0±1,306.9	0.11
Initial systolic BP	107.7±2.2	97.0±10.2	0.29
Initial heart rate	92.9±2.3	93.6±7.1	0.94

*FNOM = failed NOM.

Table 4. Comparison the clinical data of members of the OP and SNOM groups that underwent angioembolization

Variable	OP*-group (n=13)	SNOM† group with embolization (n=18)	P
Mean age	45.4±5.0	47.8±4.8	0.739
55 years old	5	23	
Injury severity scale	22.6±3.6	30.0±3.5	0.166
Glasgow coma scale			0.619
Organ injury scale	3.8±0.3	3.6±0.1	0.592
Hospital stay	24.5±5.4	27.3±6.6	0.763
Transfusion	3,286.2±744.1	3,506.7±1,758.7	0.920
Initial systolic BP	100±10.1	95.6±5.9	0.689
Initial heart rate	90.2±4.8	98.7±5.6	0.274

*OP = operation; †SNOM = successful NOM.

DISCUSSION

The spleen plays a major protective role against overwhelming sepsis caused by encapsulated organisms.(*8*) The clinical significance of the spleen had not been recognized until a report was issued in 1952 of fulminant sepsis in five infants who had undergone splenectomy.(*9*) Furthermore, the spleen is the most commonly injured abdominal organ during trauma, and splenic damage it is consistently accepted as an indication for exploration in cases with hemodynamic instability (systolic blood pressure <90 mmHg, HR>120/minute) despite fluid resuscitation, suspicion of other injuries, continuous bleeding, or splenic hilar injury. Operative management for splenic injuries was the rule before the clinical significance of the spleen was recognized, but since, surgeons have attempted several operative and non-operative management modalities that preserve the spleen.

The nonoperative management of splenic injury has evolved since the first observation by Douglas and Simpson1 that injured children can be successfully treated without splenectomy.(*10*) During the past two decades, the management of splenic injuries has shifted from operative to nonoperative management (NOM) in hemodynamically stable cases.(*1,2*) Furthermore, recent studies on the NOM of splenic injuries have demonstrated that 62 to 69% of adults are being managed without operation and that the success rate of NOM in adults varies from 75 to 94%. (*6,11,12*)

It is generally accepted that the criteria for NOM are; hemodynamic stability, no sign of peritonitis, no <blush by CT, the absence of other clear indications for exploratory laparotomy, the absence of underlying medical diseases associated with a bleeding tendency, and an injury grade of I to III.(*13*) The inclusion criteria for NOM, which remain controversial, continue to evolve despite reported failure rates of 15 to 40%.(*3,4*) Hemodynamic stability is largely accepted as the most important criterion for NOM, but other criteria, such as, an advanced age, ISS, high-grade OIS and other combined injures do not appear to be absolute contraindications of NOM.(*1,6*) In the present study, overall ISS and OIS were found to be associated with FNOM. Mean ISS was significantly higher in the FNOM group than in the SNOM group (P=0.01). In addition, the FNOM group had a significantly higher mean OIS (P=0.00). Nevertheless, controversy regarding indications continues, although several studies have suggested that adults over 55 years old be excluded because of their high treatment failure and mortality rates. In addition, blood flow is less likely to be stanch spontaneously in older adults and the risks of ongoing hemorrhage are substantially greater. Moreover, it is well known that the elasticity of the rib cage decreases with age, for example, in adults, the ribs are more apt to fracture, which increases the risk of severe splenic injury.(*5,6*) Lisa et al, in a retrospective population study on 1633 patients observed a 15% failure rate in patients >55 years of age with an ISS higher than 25 score.(*5*)

On the other hand, Christine et al(*6*) in a single institution study on 375 patients found no difference between the failure rates of adults >55 and <55 years old with blunt splenic injury (17 vs 14%). However, even in this study, older adults had significantly higher mortality because of more severe associated injuries. In the present study, SNOM occurred in 113 of 118 (95.8%) patients and FNOM in 5 (4.2%). 20 patients underwent NOM after splenic embolization and 1 (5%) of these failed. There were 32 patients >55 years old (range, 55~87 years), 26 (81%)

of these underwent NOM and 3 (11.5%) failed. However, it remains debatable as to whether older adults and a high grade injury should be managed nonoperatively.(*5,6*) Several studies have shown that an age older than 55 years and an injury grade of IV to V are valuable predictors, but that they do not constitute contraindications to NOM.(*1,6*)

Considerations of the extension of NOM criteria appear to be reasonable. Prompt clinical assessment based on ultrasonography or CT and rigorous patient selection (using clinical parameters, such as, ISS, OIS, and likely transfusion requirement) are likely to enable successful NOM in hemodynamically stable patients. In terms of angioembolization, it is more commonly used to manage high grade injuries (grades IV or V).(*6,11,14-16*)

This study has several limitations. The most obvious of which are its retrospective design and the small number of patients evaluated. Accordingly, we would like to suggest that a randomized clinical study be performed to evaluate the usefulness and safety of NOM for the treatment of splenic injuries, but ethical and practical considerations would prevent such a trial. Furthermore, the follow-up was not enough to evaluate the delayed complications of splenic angioembolization, such as, splenic infarction, abscesses, and splenic cysts. However, long-term follow up was difficult in our cohort by it would have meant asking asymptomatic patients to return to hospital after discharge.

The NOM of patients with a splenic injury is moving toward being the management standard for hemodynamically stable patients. However, we consider that indications for NOM could be expanded by judiciously selecting patients based on reviewing clinical data regarding the severity of splenic injury and by aggressively accepting angioembolization.

REFERENCES

1) Malhotra AK, Fabian TC, Croce MA, Gavin TJ, Kudsk KA, Minard G, et al. Blunt hepatic injury: a paradigm shift from operative to nonoperative management in the 1990s. Ann Surg 2000;231:804-13.
2) Schwab CW. Selection of nonoperative management candidates. World J Surg 2001;25:1389-92.
3) Rutledge R. The increasing frequency of nonoperative management of patients with liver and splenic injuries. Adv Surgery 1996;30:385-415.
4) Cogbill TH, Moore EE, Jurkovich GJ, Morris JA, Mucha P Jr, Shackford SR, et al. Nonoperative management of blunt splenic trauma: a multicenter experience. J Trauma 1989;29:1312-7.
5) McIntyre LK, Schiff M, Jurkovich GJ. Failure of nonoperative management of splenic injuries; cause and consequence. Arch Surg 2005;140:563-8.
6) Cocanour CS, Moore FA, Ware DN, Marvin RG, Duke JH. Age should not be a consideration for nonoperative management of blunt splenic injury. J Trauma 2000;48:606-10.
7) Baker SP, O'Neill B, Hadden W, Long WB. The injury Severity Score: a method for describing patients with multiple injuries and evaluating emergency care. J Trauma 1974;14:187-97.
8) Morris DH, Bullock FD. The importance of the spleen in resistance to infection. Ann Surg 1919;70:513-21.
9) King H, Shumacker HB. Splenic studies. Susceptibility to infection after splenectomy performed in infancy. Ann Surg 1952;136:239-42.
10) Douglas GJ, Simpson JS. The conservative management of splenic trauma. J Pediatr Surg 1971;6:565-70.
11) Myers JG, Dent DL, Stewart RM, Gray GA, Smith DS, Rhodes JE, et al. Blunt splenic injuries: Dedicated Trauma surgeons can achieve a high rate of nonoperative success in patients of all ages. J Trauma 2000;48:801-5.
12) Yanar H, Ertekin C, Taviloglu K, Kabay B, Bakkaloglu H, Guloglu R. Nonoperative treatment of multiple intra-abdominal solid organ injury after blunt abdominal trauma. J Trauma 2008;64:943-8.
13) Townsend CM Jr, Daniel BR, Mark EB, Mattox KL. Sabiston Textbook of Surgery; The Biological Basis of Modern Surgical Practice. 18th ed. Philadelphia: Saunders; 2007.
14) Tominaga GT, Simon FJ Jr, Dandan IS, Schaffer KB, Kraus JF, Kan M, et al. Immunologic function after splenic embolization. Is there a difference? J Trauma 2009;67:289-95.
15) Nix JA, Costanza M, Daley BJ, Powell MA, Enderson BL. Outcome of the current management of splenic injuries. J Trauma 2001;50: 835-42.
16) Cho YP, Jung SM, Han MS, Jang HJ, Kim YH, Choi YB. Repeat CT scan for non-operative management of blunt splenic trauma. J Korean Surg Soc 2004;67:390-6.