Künt Karın Travmasına Bağlı Solid Organ Yaralanmalarında Non operatif Tedavi-Dalak Yaralanmaları

Non-operative Management In Solid Organ Injuries After Blunt Abdominal Trauma-Splenic Injuries

Mehmet Aykut Yıldırım[1], Ahmet Tekin[1], Sinan İyisoy[2], Murat Çakır[1], Cengiz Kadıyoran[3], Tevfik Küçükkartallar[1], Celalettin Vatansev[1], Faruk Aksoy[1], Metin Belviranlı[1], Adil Kartal[1]

[1]Necmettin Erbakan University Meram Medical School, Department of General Surgery, Konya, Türkiye
[2]Necmettin Erbakan University Meram Medical School, Department of Education And Medical Informatics, Konya,Türkiye
[3]Necmettin Erbakan University Meram Medical School, Department of Radiology, Konya,Türkiye

Öz

Amaç: Künt karın travmasına bağlı solid organ yaralanması olan hastalarda nonoperatif tedavi (NOT) uygulaması güncel yaklaşımdır.NOT uygulanan travmalı hastaların takibinde halen birliktelik yoktur. Çalışmamızda literatürde NOT uygulama aşamasında bazı aydınlatılmayan alanlara ışık tutmayı amaçladık.

Materyal-Metod: Çalışmamızda künt karın travmasına bağlı dalak yaralanması tespit edilen hastalar değerlendirildi. NOT başarılı olan hastalar ve NOT başarısız olup laparatomi yapılan hastalar tasnif edildi. Laparotomiye dönüş kriterlerimiz ise yeterli resusitasyona rağmen hemodinaminin instabil olması ve peritoneal irritasyon bulgularının varlığıydı.Yaralanma derecesine göre kendi içlerinde karşılaştırılarak analiz edildi.Gruplar karşılaştırılırken demografik bilgiler, travmanın oluş şekli,girişteki hemodinamik durum, BT'de yaralanmanın derecesi, yatış süresi boyunca kan ve kan ürünleri transfüzyonu gereksinimi, laparatomi gereksinimi, hastanede kalış süreleri, yoğun bakım ihtiyacı, ilk başvurudaki hemoglobin/hematokrit/lökosit sayısı değişimi ve oral beslenme zamanının tayini parametreleri kullanıldı.

Bulgular: NOT uygulanan 72 vaka retrospektif olarak değerlendirildi. 10 hastada NOT uygulanırken başarısızlıkla sonuçlandı ve laparatomi uygulandı.

Sonuç: Grade 3 ve üzeri yaralanmaların takibinde görüntüleme tetkikleri gerekebilir. NOT uygulanan hastalara hastaneye girişten itibaren yakın hemodinamik izlem, sık tekrarlayan fizik muayene ve etkin sıvı resusitasyonu yapılmalıdır. NOT uygulanan dalak travmalı hastalarda taburculuk sonrası erken dönemde yeniden kanama ve splenik abse gibi komplikasyonların olabileceği akılda tutulmalıdır.

Anahtar Kelimeler: Non-operative management, splenic injury, blunt trauma

Abstract

Introduction: Non-operative management (NOM) is the current approach in patients with solid organ injury caused by blunt abdominal trauma. In recent years, conservative treatment is successfully employed by advances in imaging modalities, interventional radiology and intensive care management. However, there is no consensus on follow-up of trauma patients undergoing NOM. In this study, we aimed to highlight controversial issues in trauma patients undergoing NOM.

Materials and methods: In this study, we retrospectively assessed with splenic injury after blunt abdominal trauma. Criteria for conversion to laparotomy include hemodynamic instability despite adequate resuscitation and presence of peritoneal irritation findings. The patients were classified as those with NOM success and those with NOM failure requiring laparotomy. Groups were compared regarding demographic characteristics, mechanism of injury, additional trauma, hemodynamic status at admission, severity of injury on CT scan, transfusion need for blood and blood products, need for laparotomy, length of hospital stay, need for ICU admission, change in hemoglobin/hematocrit value and leukocyte count, and initiation time of oral intake

Results: In 72 cases with splenic injury after blunt abdominal trauma that was managed by NOM. In 10 patients, NOM was failed and the patients underwent laparotomy. All patients underwent CT scan during initial diagnostic workshop.

Conclusion: Imaging modalities should be used in the follow-up of patients with ≥grade 3 injury. Higher grades of injury result in increased costs and prolonged hospitalization. NOM failure is increased in high grade injuries. Another factor in NOM failure is perforation of non-solid organs. Close hemodynamic monitorization, frequent physical examination and effective fluid resuscitation are essential in patients undergoing NOM. It should be kept in mind that complications such as re-bleeding and splenic abscess may occur at early period after discharge.

Keywords: Non-operative management, splenic injury, blunt trauma

Yazışma Adresi: Mehmet Aykut Yıldırım, Necmettin Erbakan University Meram Medical School, Department of General Surgery, Konya ,Turkey
E-Posta: drmayildirim@hotmail.com
Alınma Tarihi : 16.07.2019 / **Kabul Tarihi :** 17.05.2020 / **Yayımlanma Tarihi :** 15/06/2021

Genel Tıp Derg 2021;31(2)105-110

Introduction

Non-operative management (NOM) is the current approach in patients with solid organ injury caused by blunt abdominal trauma. In recent years, conservative treatment is successfully employed by advances in imaging modalities, interventional radiology and intensive care management [1, 2]. In solid organ injuries, NOM is choice of treatment in patients without hemodynamic instability [3]. However, there is no consensus on follow-up of trauma patients undergoing NOM. In this study, we aimed to highlight controversial issues in trauma patients undergoing NOM.

Materials and methods

In this study, Non-invasive clinical studies of Necmettin Erbakan University Medical Faculty were performed with the approval of the ethics committee (number of decisions: 2012/156). we retrospectively assessed 72 cases with splenic injury after blunt abdominal trauma in Necmettin Erbakan Universityt. In 10 patients, NOM was failed and the patients underwent laparotomy. Criteria for conversion to laparotomy include hemodynamic instability despite adequate resuscitation and presence of peritoneal irritation findings. The patients were classified as those with NOM success and those with NOM failure requiring laparotomy. In addition, the patients with isolated splenic trauma were compared after stratifying severity of injury. The patients were graded by using American Association for Surgery of Trauma Grading (Table 1). Groups were compared regarding demographic characteristics, mechanism of injury, hemodynamic status at admission, severity of injury on CT scan, transfusion need for blood and blood products, need for laparotomy, length of hospital stay, need for ICU admission, change in hemoglobin/hematocrit value and leukocyte count, and initiation time of oral intake. All patients underwent CT scan during initial diagnostic workshop.

The patients assigned for NOM were closely monitored after initial assessment. Blood pressures (BP), heart rate (HR), Glasgow Coma Scale (GCS), hemoglobin, hematocrit and leukocyte values at admission were recorded. Hemoglobin and hematocrit values at baseline (hour 0) and on the hours 1, 6 and 24 after admission were measured. The patients with isolated grade 1 splenic injury were monitored without admission to ICU. The patients with grade 2 and 3 splenic injury and those with additional injury other than abdominal trauma were admitted to ICU. To assess peritoneal irritation findings, physical examination was performed on hours 0, 1, 6, 12 and 24.

Table 1: American Association for Surgery of Trauma Grading

Grade	Hematoma	Laceration
1	Subcapsular: <10% surface area.	Capsular tear: <1 cm parenchymal depth
2	Subcapsular: 10-50% surface area.	Capsular tear: 1-3cm parenchymal depth not involving a parenchymal vessel
	Intraparenchymal: <5 cm diameter	
3	Subcapsular of greater than 50% of surface area or expanding and ruptured subcapsular or parenchymal hematoma	> 3 cm in depth or involving trabecular vessels
	Intraparenchymal > 5 cm or expanding	
4	Ruptured intraparenchymal hematoma with active bleeding	>3 cm parenchymal depth or involving trabecular vessels
5	Hilar vascular injury with devascularized spleen	Completely shattered spleen

* Upgrade 1 grade for multiple injury in grade 1 and 2

The patients who developed hemodynamic instability or peritoneal irritation findings within first 6 hours underwent surgery. Oral intake was allowed on the hour 24 in the patients without hemodynamic instability, findings of peritoneal irritation or significant decrease in hematocrit values. Abdominal sonography was obtained on the hour 24 in patients with hemodynamic stability but showing significant decreases in hematocrit and hemoglobin values. The patients with intra-abdominal fluid on abdominal sonography were re-assessed by abdominal CT scan. These patients were admitted to ICU until normalization of hemoglobin and hematocrit values by the consideration that hemodynamic status could be impaired.

Among the patients with isolated splenic injury who assigned to NOM and admitted to ICU, those without hemodynamic instability, peritoneal irritation findings and significant decreases in hemoglobin and hematocrit values were discharged to ward on the hour 24.

During follow-up at ward, abdominal examination (twice daily) and hemoglobin and hematocrit studies (once daily) were performed in stable patients. Vital signs were recorded with 4-hour intervals.

The patients with stable vital signs, normal physical examination and stable hemoglobin and hematocrit values who had no actual complaint (particularly abdominal pain) were discharged. Complications during follow-up, drugs administered and length of hospital stay were recorded. The billing at discharge was also recorded.

Two-week bed resting was recommended to the patients with grade 1 isolated injury whereas 3-week bed resting to those with grade 2 and 3 injury.

Outpatient control visits were scheduled on the day 3 and 7 after discharge. In control visits, vital signs were recorded. Complete blood count and sonography were performed in patients with abdominal pain. In addition, control visits on the months 1, 3 and 6 were scheduled in all patients, in which the patients were assessed by detailed history and physical examination. The patients with complaint were assessed by completed blood count, sonography or CT scan. In this study, patients were observed without interacting with therapeutic process and findings were recorded.

Statistical analysis

Data obtained were analyzed by using SPSS for Windows version 21.0. Kruskal-Wallis, chi-square, Mann Whitney U, ANOVA and Tukey HSD tests were used for statistical analysis. Data were presented by tables. A p value<0.05 was considered as statistically significant.

Results

In the study, mean age was 30.75 years in patients with splenic injury who underwent NOM whereas 25.60 years in those with NOM failure (p>0.05). There were 16 women (22.2%) and 56 men (77.8%) in NOM group whereas there were 3 women (30%) and 7 men (70%) in the group with NOM failure (Table 2).

When mechanism of injury was assessed in patients with splenic injury who underwent NOM, it was found that there were 6 (8.3%) out-of-vehicle traffic accidents, 37 (51.4%) in-vehicle traffic accidents, 22 (30.6%) motorcycle accidents and 7 (9.7%) falls. There were 6 (60%)

in-vehicle traffic accidents, 3 (30%) motor cycle accidents, and one (10%) fall among patients with NOM failure. In addition,

Table 2: Comparison of patients with isolated splenic injury who underwent NOM or those with NOM failure

Parameters	NOM n=72	NOM failure n=10	p
Mean age	30.75	25.60	p>0.05
Gender	M	M	p>0.05
	78%	70%	
	F	F	
	22%	30%	
Hemodynamic status (first assessment)	Stable 93%	Stable 60%	p<0.05
TA mmHg	112 mmHg	98 mmHg	p<0.05
Heart rate/min	86/min	99/min	p<0.05
GCS	>13	>11	p<0.05
Hemoglobin(g/dl)	12.6	11.3	p>0.05
Hematocrit (%)	37.4	31	p<0.05
Leukocyte (K/mm3)	14.9	16.9	p<0.05
(ü)	1	2.9	p<0.05
Length of ICU stay(days)	2.6	4.1	p<0.05
Length of hospital stay (days)	6.9	9.9	
Severity of injury			
Grade 1	45.8%	0	
Grade 2	36,10%	20%	p<0.05
Grade 3	18,10%	80%	

it was seen that there were 33 grade 1 (45.8%), 26 (grade 2 (36.1%) and 13 grade 3 injuries (18.1%) among patients underwent NOM whereas two grade 2 (20%) and 8 grade 3 injuries (80%) among patients with NOM failure. Hemodynamic status at presentation was considered as instable in 5 patients (6.9%) and stable in 67 patients (93.1%) among those who underwent NOM. All patients with hemodynamic instability were stabilized after first resuscitation. In the NOM failure group, there was 4 patients (40%) with hemodynamic instability and 6 patients (60%) without hemodynamic instability (p<0.05; Table 2 and 3).

Mean blood pressure and heart rate were calculated as 112 mmHg and 86.02/min in patients with splenic injury who underwent NOM, while 98.9 mmHg and 99/min in those with NOM failure, respectively (p<0.05). There was no significant difference in age, gender and mechanism of injury while there was significant difference in hemodynamic instability and severity of injury between groups.

The mean hemoglobin, hematocrit and leukocyte values at admission were calculated as 12.6 g/dL, 37.4% and 14,900/µL in patients with splenic injury who underwent NOM while 11.3 g/dL, 31.04% and 16,900/µL in patients with NOM failure, respectively (p<0.05). Hemoglobin and hematocrit values were lower while leukocyte count was higher in patients with NOM failure when compared to those with splenic injury who underwent NOM. The difference was significant for hematocrit value and leukocyte count (p<0.05) but not for hemoglobin value (p>0.05; Table 2).

Table 3: Comparison of splenic injuries according to grade of injury

Parameters (mean)	Grade 1 n=33	Grade 2 n=26	Grade 3 n= 13	Kruskal-Wallis Test	Mann Whitney U Test*
BP (mmHg) (first assessment)	123	111	107	P<0.001	1-2 P=0.009
HR (min) (first assessment)	80.6	80.54	92.33		2-3 P=0.032
Hemoglobin (g/dl) (first assessment)	13.46	12.44	12.05		1-3 P<0.001
Hematocrit (%) (first assessment)	39.49	35.81	40.4		
Leukocyte (u/L) (first assessment)	14.58	13.04	16.32		
Length of ICU	0.31	0.86	1.66	P=0.008	1-2 P=0.147
Stay (days)	Min:0	Min:0	Min:3		2-3 P=0.059
	Max:2	Max:2	Max:7		1-3 P=0.006
Length of hospital stay(days)	2.94	3.26	4.58		

When amount of blood transfusion during hospitalization was assessed, it was found as 1 unit in patients with splenic injury who underwent NOM while 2.9 units in those with NOM failure. It was seen that mean amount of blood transfusion was significantly lower in patients underwent NOM (p<0.05; Table 2).

Mean length of ICU stay was found as 2.6 days in patients underwent NOM whereas 4.1 days in those with NOM failure. There was significant difference in length of ICU stay between patients (p<0.05; Table 2).

Mean length of hospital stay was found as 6.9 days in patients underwent in patients underwent NOM whereas 9.9 days in those with NOM failure, indicating significant difference (p<0.05; Table 2).

When blood pressure was assessed according to severity of injury in patients underwent NOM, it was found that mean blood pressure was 123.31, 111.83 and 115.32 mmHg in patients with grade 1, grade 2, and grade 3 injury, respectively. Mean heart rate was found as 80.6, 80.54 and 92.33/min in patients with grade 1, grade 2, and grade 3 injury, respectively. When blood parameters were assessed, it was found that mean hemoglobin values were 13.4, 12.4 and 12.05 g/dL whereas 39.49%, 35.81% and 40.4% in patients with grade 1, grade 2, and grade 3 injury, respectively. Mean leukocyte count was found to be 14,500, 13,040, and 16,320/µL in patients with grade 1, grade 2, and grade 3 injury, respectively. There was significant difference in blood pressure values between grade 1-3 and grade 1-2 by increasing severity of injury (Anova test; p<0.05). There was no significant difference in blood pressure between patients with grade 2 and grade 3 injury (Tukey HSD test; p>0.05). Significant differences were detected in blood pressure and heart rate between groups (p<0.05). Although there were numerical differences, no significant difference was detected in hematocrit, hemoglobin and leukocyte values (p>0.05; Table 3).

In patients with isolated splenic injury who underwent NOM, mean length of ICU stay was 0.31, 086 and 1.66 days whereas mean length of hospital stay was 2.94, 3.26 and 4.58 days in grade 1, grade 2, and grade 3 injury (p<0.05), respectively (Kruskal-Wallis test; p<0.05 for each parameter). It was found that lengths of ICU and hospital stay were significantly prolonged by increasing severity of injury (Table 3).

Among patients with NOM failure, 2 patients underwent surgery due to peritoneal irritation findings while 8 patients underwent hemodynamic instability. Active bleeding was observed in 4 of patients underwent surgery due to hemodynamic instability. Of these more severe injury was detected in 2 patients during surgery than those assessed by CT scan. In remaining 2 patients, grade 3 injury with parenchymal bleeding was observed and splenoraphy was performed. In 4 patients underwent surgery due to hemodynamic instability, it was observed that there was no active bleeding, implying unnecessary surgery. There was empty organ perforation (jejunum) in 2 patients underwent surgery due to peritoneal irritation findings, These patients had grade 2 injury while no active bleeding was observed during surgery (Table 4)

Table 4: Assessment of patients during laparotomy

Groups	Grade 1	Severity of injury rated by CT scan			Reason for laparotomy		Operative findings			Unnecessary laparotomy
		Grade 2	Grade 3	Acute abdomen	Hemodynamic instability	Bile peritonitis	Empty organ perforation	Operative >grade 3		
NOT failure	n	0	2	8	2	8	0	2	2	4
	%	0	20	80	20	80	0	20	40	40

Of the 72 patients who underwent surgery, parenchymal extravasation was seen in CT at the initial diagnosis. Hemoglobin / hematocrit decay was not observed in hemodynamically stable patients. In control USG, the perisplenic fluid seen in FAST was not increased. So control CT was not done.

In postoperative care follow-up, 7 patients underwent a significant decrease in hemogram examination. Her physical examination was normal. There was no significant difference in the initial USG evaluation.

No complication was observed in 69 (95.48%) while complication occurred in 3 (4.16%) of patients underwent NOM. One patient underwent splenectomy due to hemorrhage caused by delayed splenic rupture on the day 14 after discharge. In remaining 2 patients, splenic abscess was detected on the day 7 after discharge. The patients with splenic abscess were treated by antibiotic therapy and percutaneous drainage. In these patients, severity of injury was rated as grade 3.

Of 72 patients underwent NOM, 5 (6.94) had complaints in the control visit on the month 1. These complaints included occasional abdominal pain and shoulder pain at left. Physical examination, complete blood count and sonography evaluations were normal in these patients. No complaint was reported by the patients in the control visits on the month 3 and 6.

Mean cost was 626.44 TL in patients who underwent NOM while it was 4918.70 TL in those with NOM failure. It was seen that the patients who underwent NOM were managed with significantly lower costs than those with NOM failure ($p<0.05$).

It was found that failure rate was increased while length of hospital stay was prolonged by increasing severity of injury as assessed by CT scan. In addition it was found that need for ICU care and blood transfusion, costs and complication rates were increased by severity of injury. No imaging modality was required in low grade splenic injury.

Discussion

Conservative treatment has become an important therapeutic option for patients without hemodynamic instability in the management of abdominal solid organ injury caused by blunt trauma (4-8). Before non-operative treatment, surgical exploration was the treatment modality employed in solid organ injuries caused by blunt trauma. The successful use of non-operative treatment in pediatric patients with splenic injury and hemodynamic stability has led the use in adult patients [4, 5]. While In recent years, noon-operative treatment is increasingly used with success by advances in imaging modalities, interventional radiology and intensive care therapy, rate of surgical exploration has decreased in recent years. In addition, it was reported that non-operative treatment is associated less morbidity and mortality when compared to operative treatment while surgical treatment further increases bleeding in the literature [9-13]. Non-operative treatment is indispensable in patients with solid organ injury and hemodynamic stability; however, it remains to define its effectiveness and management steps [4, 5, 9, 11, 14]. There are also questions regarding patient selection.

When non-operative treatment was first introduced, factors such as age>55 years, presence of head trauma, higher severity of injury, presence of blood at periportal area, contrast material extravasation on CT scan, trauma score, amount of intraperitoneal blood and amount of blood transfusion were reported as major barriers for non-operative treatment [4, 5]. In the literature, there are studies that consider factors including age>55 years, contrast material extravasation on CT scan, neurological status, higher grade of injury on CT scan and amount of intraperitoneal blood as absolute contraindications for non-operative treatment [12, 14, 15, 16]. However, there are studies advocating that age and severity of injury should be disregarded in patients with hemodynamic stability [17]. In our study, hemodynamic instability and peritoneal irritation findings were preferentially taken into account in patients with hepatic trauma when employing non-operative treatment. In our study, there were patients older than 55 years who underwent non-operative treatment due to hepatic injury or splenic injury. Mean age was 30.75 years in patients who underwent non-operative treatment. We believe that age has no influence on none-operative treatment.

Hemodynamic instability accounts for 75% of NOM failures. Delayed bleeding is seen in 2.8-3.5% of patients, which is reported as most common cause of mortality [11]. In our patients with NOM failure, the decision of surgical treatment was made based on hemodynamic instability and peritoneal irritation findings. There were 8 patients who underwent surgery due to hemodynamic instability. Intraoperatively,

it was found that there was no active bleeding in 4 patients while there was ≥ grade 3 injury (higher than rated by CT scan) in 4 patients. We think that hemodynamic instability was solely due to inadequate resuscitation in patients without active bleeding. In the literature, the rate of NOM failure has been reported as 8-38% [44]. In consistent to literature, it was found as 12.1% in our study.

In our study, complications were observed after discharge in 3 patients (4.16%) who underwent NOM, including splenic rupture (1.38%) and splenic abscess (2.7%). We think that the incidence of complications increases by increasing severity of injury. Splenic abscess was treated by percutaneous drainage and antibiotic therapy.

Definitive treatment is surgical exploration in patients with hemodynamic instability and in those peritoneal irritation findings [18, 19]. In addition, surgical treatment should be considered in case of suspected empty organ perforation and escalating abdominal pain [20]. In a study on 227,972 patients with blunt abdominal trauma, Fakhyr et al. found the rate of empty organ perforation as 0.3% [12]. In our study, empty organ perforation was detected in 25% of patients with NOM failure. The intestinal organ perforation was the cause of peritoneal irritation in two patients with NOM failure of splenic injury.

In the management, CT scan is the most appropriate diagnostic modality in hemodynamically stable patients with blunt abdominal trauma. In addition, it has been reported that CT scan is rather useful to demonstrate pneumoperitoneum, retroperitoneal bleeding, amount of intraperitoneal bleeding and active bleeding [22-24]. In the literature, it was reported that CT isn't indicated in routine follow-up; however, it is indicated in presence of acute, unexplained decreases in hemoglobin and escalating abdominal pain [25, 26]. In the literature, there are studies reporting that 14.5% of surgeons use CT in the follow-up patients undergoing NOM [36]. In addition, it has been emphasized that repeated CT scans don't change treatment and that they are required for diagnosis of delayed pseudoaneurysm formation [27, 28]. In our study, no routine imaging study was performed before discharge. CT scan was used in the diagnosis of all patients in our study. We recommend using CT scan in case of marked decrease in stabilized hemoglobin and hematocrit value, increased intra-abdominal fluid in sonography, and suspicious physical examination findings.

Need for continuous resuscitation, higher grade of injury, multiple solid organ injury, large hemoperitoneum and contrast material extravasation in CT scan have been reported as factors involved in NOM failure. In addition, it has been emphasized that such patients should require angioembolization or laparotomy [17, 19,45]. It has been reported that concurrent splenic and hepatic injury causes prolonged length of hospital stay, increased amount of blood transfusion and higher failure rate when compared to single organ injury; in addition, it was also reported that failure rate is high in grade 4 and 5 injuries [3, 5, 7, 9, 32, 33,45]. In a previous study, it was reported that 6.9-66.7% of patients who presented with splenic trauma underwent emergent laparotomy [34]. In some centers, surgical intervention is recommended as sole therapeutic modality for contrast extravasation on CT scan and high grade trauma. In a study, it was reported that presence of contrast material extravasation isn't an absolute indication for surgery but may be indication for angioembolization [35]. In solid organ injuries caused by blunt trauma, particularly in splenic injury, angiography and embolization is recommended to hemodynamically stable patients if there is ≥grade 3 injury, moderate hemoperitoneum and contrast material extravasation on CT scan [5, 37-40]. Some authors performed angiography to all cases with contrast material extravasation on CT scan; however, they reported that embolization was performed in only 5-7% of these patients and no bleeding was observed in some patients [41, 42]. Some authors reported that they don't routinely perform angiography or surgery in all cases with contrast material extravasation [36,47]. In our study, there was no multiple solid organ injury among patients underwent NOM. In addition, the patients with contrast material extravasation at diagnosis were stable in hemodynamic manner. We think that contrast material extravasation can be managed by close monitorization and complete blood count unless hemodynamic instability develops. We think that the increase of perisplenic fluid by control USG can be followed for bleeding in patients with contrast extravasation. In addition, we think that large or expanding hematoma is a factor that affects success of NOM. No angiographic study was performed in our patients underwent non-operative therapy but it might be used in patients with instable hemodynamic and peritoneal irritation findings. However, lack of our experience in this issue affects feasibility of angiography.

Non-operative treatment includes serial physical examination, frequent measurements of hemoglobin and hematocrit values, close monitorization and bed resting. In the literature, there is no definitive data regarding duration and execution of above-mentioned procedures as well as need for ICU, timing of oral intake and duration of bed resting [10]. Non-operative treatment is recommended in patients without hemodynamic instability and peritoneal irritation findings in facilities where frequent physical examination, blood tests and close monitorization are available and has ability to manage complications and to perform emergent laparotomy [4, 5, 19]. It was reported that 2-days bed resting at hospital could be sufficient in grade 1 and 2 injuries [46]. In pediatric studies, it was reported that the patients discharged on the day 3 in earliest cases and 8-week bed resting is recommended after discharge. Some authors reported that they performed continuous monitorization in grade 1 and 2 injuries and that they discharged the patients with grade 1 injury after one or two days of hospitalization if hemoglobin and hematocrit values are stable. They also emphasized that length of hospitalization prolongs by increasing severity of injury [36]. In the literature, it was emphasized that hemoglobin and hematocrit measurements should be performed at admission and on the hours 6, 8 and 24 [2]. We think that hemoglobin and hematocrit values should be measures on the hours 0, 1, 6 and 24 within first 24 hours and once daily at subsequent days. We recommend performing physical examination on the hours 0, 1, 6, 12, and 24 within first 24 hours and twice daily at subsequent days. In addition, we think that 2 days of hospitalization for grade 1 and 2 injuries whereas 4 or 5 days of hospitalization for grade 3 injury. We think that it will be appropriate to follow grade 1 patients with isolated solid organ injury by monitoring at ward whereas one or two days of ICU admission will be needed in patients with grade 2 and 3 injuries. We also recommend initiating oral intake after 24 hours in hemodynamically stable, conscious patients without peritoneal irritation findings. We believe that 3-week resting will be appropriate for patients with grade 1 and 2 whereas 4-week resting for patients with grade 3 injury. In the literature, it was suggested that treatment cost is lower in patients underwent NOM when compared to surgery

[4, 5, 18]. In our study, it was seen that treatment cost was lower in patients underwent NOM when compared to those underwent surgery and that costs increased by increasing severity of injury.

Conclusion

Imaging modalities should be used in the follow-up of patients with ≥grade 3 injury. Success rate is higher in low grade splenic and hepatic traumas. Higher grades of injury result in increased costs and prolonged hospitalization. Today, advances in endoscopic procedures and interventional radiology improve success in non-operative treatment. NOM failure is increased in high grade injuries. Another factor in NOM failure is perforation of non-solid organs. Close hemodynamic monitorization, frequent physical examination and effective fluid resuscitation are essential in patients undergoing NOM. It should be kept in mind that complications such as re-bleeding and splenic abscess may occur at early period after discharge.

References

1. Burch JM, Francoise RJ, Moore E. Trauma. In: Brunicardi FC editor. Schwartz Principles of Surgery 10. Edition. McGraw-Hill,2017.
2. Izu BS, Ryan M, Markert RJ, et al. Impact of splenic injury guidelines on hospital stay and charges in patients with isolated splenic injury. Surgery.2009;146:787-791.
3. Sabe AA, Claridge JA, Rosenblum DI, et al. The effects of splenic artery embolization on non-operative management of blunt splenic injury: a 16-year experience. J Trauma. 2009;67:565-572.
4. Sayek İ. Temel Cerrahi. In: Kayanaroğlu Z.V. Karın Travmaları. 3 th ed, Güneş Kitabevi Ltd. Şti. Ankara. 2004. P:466
5. Ruscelli P, Gemini A, Rimini M, Santella S, Candelari R et al. The role of grade of injury in non-operative management of blunt hepatic and splenic trauma: Case series from a multicenter experience. Medicine (Baltimore). 2019 Aug;98(35):e16746
6. TUİK, Ölüm Nedeni İstatistikleri. 2010,2011,2012.
7. Fu CY, Wu SC, Chen RJ, Chen YF, Wang YC et al. Evaluation of need for operative intervention in blunt splenic injury: intraperitoneal contrast extravasation has an increased probability of requiring operative intervention. World J Surg. 2010;34: 2745-2751
8. Taviloğlu K, Ertekin C, Güloğlu R. Travma ve resüsitasyon Kursu In: Ertekin C. Karın Travmaları. Logos yayıncılık Nisan 2006
9. Richard M Bell. Brent E. Krantz: Initial Assessment. In: Mattox KL, Felliciano DV, Moore EE. Trauma, 4th ed. McGraw Hill, New York, 154- 169, 2000.
10. Malhotra AK, Fabian TC, Croce MA, Gavin TJ, Kudsk KA, Minard G, Pritchard FE. Blunt hepatic injury: a paradigm shift from operative to nonoperative management in the 1990s. Ann Surg 231:804;2000
11. Fata P, Robinson L, Fakhry SM. Survey of EAST member practices in blunt splenic injury: a description of current trends and opportunities for improvement. J Trauma 59:836,2005
12. Burch JM, Moore E. Bölüm Türkçe Çeviri: Şahbaz A, Taviloğlu K. Karaciğer , Safra Yolları, Dalak ve Diyafragma Yaralanmaları. In: Sauba W, Fink M, editors. ACS Surgery Principles&Practice. Özmen M, Özmen V. Türkçe Çev. Ed. 6. Edition . BC Decker 2012.
13. King H, Shumacker HB, Splenic studies: Susceptibility to infection after splenektomi performed in infancy. Ann Surg 136: 239,1952
14. Karp MP, Cooney DR, Pros GA,et al: The nonoperative management of pediatric hepatic trauma. J Pediatr Surg 18:521,1983
15. Godley CD, Warren RL, Sheridan RL, et al: Nonoperative management of blunt splenic injury in adults: age over 55 years as a powerful indication for failure. J Am Coll Surg .183:133-138, 1996.
16. Gorge C. Velmahos, Linda S. Chan, Eman Kamel, et al:Nonoperative management of splenic injuries:Have we gone too far ?.Arch Surg. 135:674- 681,2000
17. Renz BM, Feliciano DV. Unnecessary laparotomies for trauma: a prospective study of morbidity. J Trauma 1995;38(3):350-6
18. Haan JM, Bochicchio GV, Kramer N, Scalea TM. Nonoperative management of blunt splenic injury: a 5-year experience. J Trauma. 2005;58:492-498
19. Olthof DC, Joosse P, van der Vlies CH, de Haan RJ, Goslings JC. Prognostic factors for failure of nonoperative management in adults with blunt splenic injury: a systematic review. J Trauma Acute Care Surg. 2013 ;74(2):546-57
20. Moore EE, Cogbill TH, Jurkovich GJ, Shackford SR, Malangoni MA, Champion HR. Organ injury scaling: spleen and liver (1994 revision). J Trauma. 1995;38(3):323-324.
21. van der Wilden GM, Velmahos GC, Emhoff T, Brancato S, Adams C. Successful nonoperative management of the most severe blunt liver injuries: a multicenter study of the research consortium of new England centers for trauma. Arch Surg. 2012 ;147(5):423-8.
22. Sartorelli KH, Frumiento C, Rogers FB, et al. Non-operative management of hepatic, splenic, and renal injuries in adults with multiple injuries. J Trauma. 2000;49:56-61.
23. Richardson JD, Franklin GA, Lukan JK, et al. Evolution in the management of hepatic trauma: a 25 year perspective. Ann Surg. 2000; 232:324-330.
24. Christmas AB, Wilson AK, Manning B, et al. Selective management of blunt hepatic injuries including non-operative management is a safe and effective strategy. Surgery. 2005;138:606-611
25. Stassen NA, Bhullar I, Cheng JD, Crandall M, Friese R, Guillamondegui O, et al. Nonoperative management of blunt hepatic injury: an Eastern Association for the Surgery of Trauma practice management guideline. J Trauma Acute Care Surg. 2012 ;73(5 Suppl 4):288-93.
26. Stassen NA, Bhullar I, Cheng JD, Crandall ML, Friese RS, Guillamondegui O, et al. Selective nonoperative management of blunt splenic injury: an Eastern Association for the Surgery of Trauma practice management guideline. J Trauma Acute Care Surg. 2012 ;73(5 Suppl 4):S294-300
27. Schroeppel TJ, Croce MA. Diagnosis and management of blunt abdominal solid organ injury. Curr Opin Crit Care. 2007 ;13(4):399-404.
28. Smith SJ, Cooney RN, Mucha P: Nonoperative management of the ruptured spleen: a revalidation of criteria. Surgery.1996; 120: 745-775.
29. Smith JS Jr, Wengrowitz DA, DeLong DS: Prospective validation of criteria, including age, for safe non-surgical management of the ruptured spleen. J Trauma. 1992; 33: 363-369.
30. Croce MA, Fabian TC, Menke PG, et al: Nonoperative management of blunt hepatic trauma is the treatment of choice for hemodynamically stable patients. Ann Surg. 1995; 221:744-755.
31. Fang JF, Chen RJ, Lin BC, Hsu YB, Kao JL,Chen MF. Blunt hepatic injury: minimal intervention is the policy of treatment. J Trauma 2000;49:722-8
32. Scarborough JE, Ingraham AM, Liepert AE, et al. Nonoperative Management Is as Effectiveas Immediate Splenectomy for Adult Patients with High-Grade Blunt Splenic Injury. J Am Coll Surg 2016; 223:249.
33. Velmahos GC, Toutouzas K, Radin R, et al. High success with nonoperative management of blunt hepatic trauma: the liver is a sturdy organ. Arch Surg. 2003;138:475Y480; discussion 480-481.
34. Watson GA, Rosengart MR, Zenati MS, et al. Nonoperative management of severe blunt splenic injury: are we getting better? J Trauma 2006; 61:1113.
35. Bhullar IS, Frykberg ER, Tepas JJ 3rd, et al. At first blush: absence of computed tomography contrast extravasation in Grade IV or V adult blunt splenic trauma should not preclude angioembolization. J Trauma Acute Care Surg 2013; 74:105.
36. Velmahos GC, Toutouzas K, Radin R, et al. Non-operative treatment of blunt injury to solid abdominal organs: a prospective study. Arch Surg.2003;138:844-851.
37. Pachter HL, Knudson MM, Esrig B, et al. Status of non-operative management of blunt hepatic injuries in 1995: a multicenter experience with 404 patients. J Trauma. 1996;40:31-38.
38. Cachecho R, Clas D, Gersin K, Grindlinger GA. Evolution of the complex liver injury at a Level I trauma center. J Trauma. 1998;45:79-82.
39. Falimirski ME, Provost D. Nonsurgical management of solid abdominal organ injury in patients over 55 years of age. Am Surg. 2000;66:631-635.
40. Sharma OP, Oswanski MF, Singer D, et al. Assessment of non-operative management of blunt spleen and liver trauma. Am Surg. 2005;71: 379-386.
41. Yanar H, Ertekin C, Taviloglu K, Kabay B, Bakkaloglu H et al. Nonoperative treatment of multiple intra-abdominal solid organ injury after blunt abdominal trauma. J Trauma. 2008;64(4):943-8.
42. Carrillo EH, SpainDA,WohltmannCD, et al. Interventional techniques are useful adjuncts in non-operative management of hepatic injuries.J Trauma. 1999;46:619-624.
43. Becker CD, Mentha G, Terrier F. Blunt abdominal trauma in adults: role of CT in the diagnosis and management of visceral injuries. Part 1: liver and spleen. Eur Radiol. 1998;8:553-562.
44. Brasel KJ, DeLisle CM, Olson CJ, et al. Trends in the management of hepatic injury. Am J Surg. 1997;174:674-677.
45. Swaid F, Peleg K, Alfici R, et al. Concomitant hollow viscus injuries in patients with blunt hepatic and splenic injuries: an analysis of a National Trauma Registry database. Injury 2014; 45:1409.
46. Mehall JR, Ennie JS, Saltzzman DA, et al. Prospective Results of a standardized algorithm based on hemodynamic status for managing pediatric solid organ injury. J Am Coll Surg. 2001;193:347-353.
47. Banerjee A, Duane TM, Wilson SP, et al. Trauma center variation in splenic artery embolization and spleen salvage: a multicenter analysis. J Trauma Acute Care Surg 2013;75:69.