NON-OPERATIVE MANAGEMENT OF SOLID ORGAN LACERATION CAUSED BY BLUNT TRAUMA

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ABSTRACT

***Aims**: This study aims to examine, combined with the literature, the non-operative examination criteria and factors effecting the morbidity and mortality of patients admitted to our clinic as a result of solid organ laceration caused by blunt trauma in those who are non-operatively treated.*

***Materials and methods**: In this study, 22 patients with blunt trauma who were non-operatively treated from December 2008 untill May 2014, were studied retrospectively. Parameters included in the study were determined as follows: vital functions at the moment of admittance, radiologic findings, need of blood transfusion and duration of hospital stay.*

***Results**: By imaging methods (ultrasonography, computed tomography) it was determined that 11 out of 22 patients of the patients had a liver laceration (grade 1-2) and 11 (50%) had a spleen laceration (grade 1-4). Nineteen patients were not observed with hematocrit or hemoglobin decrease, which would have caused the need of a blood transfusion. One patient with spleen laceration grade 4 and treated with non-operative medical monitoring (NOM) received 4 red blood cell (RBC) units; 1 patient with grade 3 spleen laceration who was operated on in the 24th hour of NOM received 4 RBC units; 1 patient with grade 4 spleen laceration who was operated on in the 10th hour of NOM received 5 RBC units. All patients were discharged without development of any complications or mortality.*

***Conclusion**: The non-operative treatment of solid organ laceration caused by blunt force trauma is a modern treatment method that can be effectively and safely applied to patients who do not have acute abdominal findings and whose vital findings remain stable, especially when located at experienced and specialized centers. Presently it is possible for patients who are monitored non-operatively to be treated safely with low morbidity and mortality rates thanks to the advanced technology of radiologic examinations and to the growing experience on this matter.*

***Key words**: Blunt trauma, non-operative management.*

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Introduction

Non-operative medical monitoring (NOM) of solid organ laceration caused by blunt trauma can be applied very successfully by close hemodynamic follow-up of the patients whose vital signs are stable at the centers where technologic facilities of imaging devices are available. Abdominal trauma is the 3rd most frequent reason for cause of death[1]. A decline of 50% at the mortality rate can be seen in case of early diagnosis and treatment[2]. Abdominal injury occurs at 30% of multiple trauma patients. 13% of the patients are diagnosed with spleen laceration and 16% with liver laceration[3].

The NOM application after blunt abdominal trauma currently results in reduction of unnecessary laparotomies, lower intra-abdominal complications, low rates of blood transfusion, lower mortality rates and reduced hospital costs; thus, this is a method which is becoming increasingly popular[4]. The most important factor that makes the application of NOM in trauma patients so widespread is the easier access to imaging methods like ultrasonography (USG) and computer tomography (CT). Thus, the first imaging examination to be performed after detailed physical examination on a trauma patient referred to the emergency department (ED) because of a trauma, is an abdominal USG (FAST= Focused

Assessment with Sonography in Trauma). This study aimed to analyze the non-operative monitoring criteria and the factors affecting morbidity and mortality of patients to whom non-operative monitoring was applied after they were referred to our clinic with a solid organ laceration caused by blunt trauma.

Materials and methods

During this study, 22 patients with blunt trauma who were treated with non-operative monitoring from December 2008 untill May 2014, were studied retrospectively. During this time, a total of 48 patients with solid organ laceration caused by blunt trauma were referred to our clinic and 22 (45.8%) of them were treated with NOM. 26 out of 48 patients needed exploration because their hemodynamic parameters were breaking down (hypotension, tachycardia) despite aggressive fluid and blood transfusions.

Parameters included in the study were: physical examination and vital signs upon application, radiological findings, need for blood transfusion, need for operation and duration of hospital stay.

Patients with the following were excluded from the study: unstable vital signs and suspicion of ongoing hemorrhage, acute abdominal examination findings, empty organ perforation seen by imaging methods, and need for emergency surgery.

Extent of liver and spleen lacerations were graded according to the organ laceration scale of American Association for the Surgery of Trauma (AAST) (table 1, table 2)[5].

Grade	Laceration type	Definition of laceration
I	Hematoma	Subcapsular, <10% surface area
	Laceration	Capsular tear, <1 cm parenchymal depth
II	Hematoma	Subcapsular, 10% to 50% surface area intraparenchymal <10 cm in diameter
	Laceration	Capsular tear 1-3 cm parenchymal depth, <10 cm in length
III	Hematoma	Subcapsular, >50% surface area of ruptured subcapsular or parenchymal hematoma intraparenchymal hematoma >10cm or expanding
	Laceration	>3 cm parenchymal depth
IV	Laceration	Parenchymal disruption involving 25% to 75% hepatic lobe or 1-3 Coinaud's segments
V	Laceration	Parenchymal disruption involving >75% of hepatic lobe or >3 Coinaud's segments within a single lobe
	Vascular	Parenchymal disruption involving >75% of hepatic lobe or >3 Coinaud's segments within a single lobe
VI	Vascular	Hepatic avulsion

Table 1: Liver injury grading scale (AAST).

Grade	Laceration type	Definition of laceration
I	Hematoma	Subcapsular, <10% surface area
	Laceration	Capsular tear, <1 cm parenchymal depth
II	Hematoma	Subcapsular, 10% to 50% surface area intraparenchymal <10 cm in diameter
	Laceration	Capsular tear, 1-3 cm parenchymal depth that does not involve a trabecular vessel
III	Hematoma	Subcapsular >50% area or expanding; ruptured subcapsular or parenchymal hematoma; intraparenchymal hematoma >5cm or expanding
	Laceration	>3 cm parenchymal depth or involving trabecular vessel
IV	Laceration	Laceration involving segmental or hilar vessels producing major devascularization (>25% of spleen
V	Laceration	Completely shattered spleen
	Vascular	Hilar vascular injury with devascularized spleen

Table 2: Spleen injury grading scale (AAST).

All patients received first application imaging methods as follows: abdominal USG (FAST) after evaluation of the physical examination and the vital findings, full body CT for patients whose hemodynamic parameters continued to be stable and who did not need urgent surgical intervention. A control USG was made at the 6th hour of the patients who were selected to receive NOM, and the inner abdominal organ laceration, hematoma and/or free fluid existence were evaluated. Within the first 12 hours, complete blood counts were pursued hourly and at the 24th hour an abdominal USG control examination was performed. On patients whose vital findings continued to be stable, an abdominal CT was taken at the 48th hour and the prevalence of the laceration and the patients' progression were evaluated one more time. All patients were tracked within the first 24 hours at the surgery intensive care unit for close monitoring.

Results

Out of total 22 patients, 4 (18.2%) had extravehicular traffic accidents, 8 (36.4%) had interior vehicular traffic accidents, 2 (9%) were hit by a falling heavy good and 8 (36.4%) patients were referred to us because they fell from a high place. The average age was determined as 41.7 (17 - 73). Twenty-one patients were male (95.4%) and only 1 (4.6%) was female. According to the imaging methods (USG, CT) 11 patients (50%) suffered 1st degree (63.6%) and 2nd degree (36.4%) liver lacerations (figure 1) and 11 (50%) suffered 1st degree (2 patients - 18,2%), 2nd degree (5 patients - 45,4%), 3rd degree (2 patients - 18,2%) and 4th degree (2

patients - 18,2%) spleen lacerations (figure 2).

Figure 1: CT image of liver laceration (grade 2 = capsular tear 1-3 cm parenchymal depth, <10 cm in length).

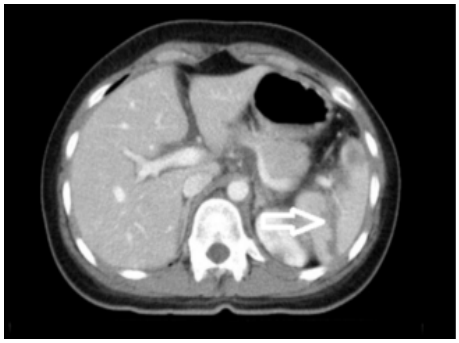

Figure 2: CT image of spleen laceration (grade 3 = >3 cm parenchymal depth or involving trabecular vessel).

It was determined that 2 patients had a fracture at the transverse process of vertebra, 1 patient had a right iliac bone fracture and 2 patients had small left perirenal hematoma. Any urgent surgical intervention was not required regarding the mentioned pathologies and no complications developed during the follow-up. No hematocrit or hemoglobin decrease, which would have made a blood transfusion necessary, was observed among the patients. The average duration of the hospital stay was determined as 4.5 days (2-10 days) (table 3). Only 1 patient with spleen laceration grade 4 and who was treated with non-operative medical monitoring (NOM) received 4 red blood cell (RBC) units in 48 hour and was discharged without having any complications.

During follow-up, two patients with 3rd and 4th degree spleen laceration showed at the 24th and 10th hours of NOM hematocrit decrease and tachycardia together with hypotension findings which could not be brought under control although fluid and blood replacement was applied (grade 3 spleen laceration = 4 RBC units; grade 4 spleen laceration = 5 RBC units). Consequently the decision for surgery (splenectomy) was selected. No post-operative complications developed and a pneumococcus vaccination was administered as a prophylaxis. All patients were discharged without having any complications or mortality development. Although the average duration of the hospital stays was 4.5 days, length of hospital stay of patients who underwent surgery, was determined to be longer (grade 3 spleen laceration = 6 days, grade 4 spleen laceration = 7 days).

Patients	Sex	Age	Trauma	Comorbidities	Injury type	Injury grade	Blood transfusions	Operation	Length of stay (day)	Morbidity	Mortality
1.	F	61	IVTA	HT+DM	SL	Grade 1	0	0	2	0	0
2.	M	37	FHG	-	LL	Grade 1	0	0	2	0	0
3.	M	36	FHG	-	LL	Grade 1	0	0	2	0	0
4.	M	41	FFH	-	LL	Grade 1	0	0	2	0	0
5.	M	41	FFH	-	LL	Grade 1	0	0	3	0	0
6.	M	32	IVTA	-	SL	Grade 2	0	0	10	0	0
7.	M	41	FFH	-	LL	Grade 1	0	0	2	0	0
8.	M	73	FFH	HT	LL	Grade 1	0	0	8	0	0
9.	M	21	IVTA	-	SL	Grade 2	0	0	7	0	0
10.	M	50	IVTA	-	SL	Grade 3	0	0	7	0	0
11.	M	59	FFH	-	LL	Grade 2	0	0	3	0	0
12.	M	44	IVTA	-	LL	Grade 2	0	0	3	0	0
13.	M	46	FFH	-	SL	Grade 2	0	0	3	0	0
14.	M	17	EVTA	-	LL	Grade 1	0	0	3	0	0
15.	M	71	FFH	HT+DM	SL	Grade 2	0	0	4	0	0
16.	M	18	EVTA	-	SL	Grade 2	0	0	5	0	0
17.	M	67	EVTA	HT	SL	Grade 4	4 RBC units	0	7	0	0
18.	M	24	EVTA	-	SL	Grade 1	0	0	4	0	0
19.	M	38	FFH	-	LL	Grade 2	0	0	4	0	0
20.	M	32	IVTA	-	LL	Grade 2	0	0	5	0	0
21.	M	38	IVTA	-	SL	Grade 3	4 RBC units	Splenectomy	6	0	0
22.	M	30	IVTA	-	SL	Grade 4	5 RBC units	Splenectomy	7	0	0

Table 3: Patients data.
F: Female, M: Male, EVTA: Extravehicular traffic accident, IVTA: Intravehicular traffic accident, FHG: Falling heavy good, FFH: Fall from height, HT: Hypertension, DM: Diabetes mellitus, SL: Spleen laceration, LL: Liver laceration, RBC: Red blood cell.

Discussion

The non-operative treatment of solid organ lacerations that developed because of blunt abdominal trauma is a current treatment, which can be applied safely and effectively at experienced and advanced centers to patients, who do not show acute abdominal examination findings and whose

vital findings continue to be stable. To date, the advanced technology of radiologic examinations (especially with USG and CT) together with the increasing experience on this subject, allows physicians to safely treat these patients non-operatively with low morbidity and mortality rate. CT and interventional radiology have influenced the conservative observation period in a very positive way[6]. The two most important parameters of non-operative follow-up are: stable vital signs and no occurrence of hollow organ perforations[7]. Higher degrees of solid organ laceration leads to lower success rates in this treatment method and therefore it is important to be more careful with patients who have a higher degree of injuries. Patients whose vital findings continue to be stable may show impairment in vital findings during the follow-up, and in this case the decision for an operation should not be delayed. The first imaging method to be used is the USG, because it is non-invasive, portable, effective and technically easy. The CT is preferable in appropriate patients to give more reliable results to determine the degree of the injury[8].

However, false negative and false positive results of imaging methods are causing questioning of those methods. The sensitivity rate for FAST, which is often used for a diagnosis after a trauma, is 42% and positive predictive rate is reported to be 67%[9]. When hemodynamics are bad, in cases of patients whose consciousness is starting to deteriorate or has already deteriorated, or when solid organ laceration and inner abdominal free fluid is determined by USG, a CT must be performed and the necessity of an operation must be considered without losing time.

The study of Peitzman et al.[10] reports the failure rate of NOM to be 30-40% and the study of Cirocchi et al. reports it to be 14.3%[11]. With this study the success rate of NOM was determined to be 91%. When the degree of solid organ injuries increased, the success rate of nonoperative treatment is reduced. The study of Brasel et al. has revealed the inverse ratio between the degree of injury and the success of nonoperative treatment.

While the success rate of all studies was 84%, success rates of 100% in the grade 1 group, 90% in grade 2, 71% grade 3, and 20% success rate in the grade 4 group were detected[12].

In our study the success rates of NOM with spleen laceration were detected as: 100% in grade 1 group, 100% in grade 2, and 50% in both grade 3 and grade 4 groups. The examination of the patient and the careful follow-up of the vital functions along with the, careful evaluation of imaging methods increase the success rate for choosing the right patient for NOM and therefore increase the rate of NOM's success. Table 4 shows the algorithm used in choosing patients who will receive NOM at first reference in our clinic.

The most important advantages of using NOM for blunt abdominal traumas are protecting splenic and hepatic functions and also decreasing complications, which may occur due to surgery. Nowadays, although the possibility of overlooking additional intra-abdominal lacerations is very low due to sophisticated imaging methods, this is one of the most important risks of NOM application. Another important risk is late period hemorrhage.

USG and CT are effective imaging methods used during the follow-up. There is no widely accepted guideline in literature regarding NOM. Control durations with USG and CT, regarding follow-up frequency, may vary according to the clinics, but at our clinic, with the exception of patients with1st grade lacerations, we attain control images with USG at 6th and 24th hour as well as with CT at 48th hour. These periods may increase or decrease according to the grade of organ laceration and progression of monitored vital signs. In our opinion, the control images obtained with USG will be sufficient in cases of patients with 1st degree liver and spleen lacerations and stable continuing vital signs. Hollow organ perforation can be determined very effectively with CT, but may be overlooked although the rate here is very low. Because there are no precise criteria accepted by everyone for blunt abdominal trauma hospitalization, the most relevant parameters that should be considered are the patients' hemodynamic situation and the physical exam findings when determining follow-up and surgical intervention as needed.

However, even with the important role that imaging methods play, no method should take the place of close patient follow-up and repeated examination.

During the treatment of solid organ laceration after trauma, protection of organ functions and avoiding complications related to laparotomy are among NOM's advantages[13]. During the selection of patients who will be treated with NOM, careful physical examination and evaluation of imaging methods by a specialist team increase the success rate of the treatment. At trauma centers with the availability of intensive care for monitoring vital

signs and where it is possible to easily attain imaging examinations like USG and CT for 24 hours, high grade organ lacerations can be treated very successfully with NOM. Therefore, complications due to operation, unnecessary blood transfusion, and long term workforce loss would be avoided. In our opinion, the examination findings and the hemodynamic situation of the patient are more important than the grade of laceration seen on the imaging when the decision is made for NOM or when the decision for a surgical intervention is made during the follow-up. Although the number of patients is limited, this study shows that the non-operative treatment method for patients, who refer with blunt trauma, is applied with success at experienced centers with an expert multi-disciplinary team.

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