Noninvasive management strategy in hemodynamically unstable patients with blunt trauma

Hemodinamik yönden stabil olmayan künt travmalı hastalarda noninvaziv tedavi

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BACKGROUND

Non-operative management in abdominal injuries may reduce non-therapeutic laparatomies without increasing mortality. The aim of this study is to evaluate the results of a recently used non-invasive management strategy, in trauma patients in our institution.

METHODS

A retrospective chart review was performed. The sixty-three patients (50 males; 13 females; range 8 to 61 years) with abdominal injuries who were unstable during their admissions to our institution between July 1st, 2000 and July 1st, 2001 (the first year of the NIMS implementation) were identified and divided into three groups according to the presence or absence of surgical intervention and the timing of the operation.

RESULTS

There were 63 blunt abdominal trauma patients who were unstable during admission. Patients in Group 1 (n=14) and Group 2 (n=10) had urgent laparotomy during the resuscitation therapy or after a median observation period of 7 hours (range, 2 to 20). Group 3 patients (n=39) did not require surgical intervention.

CONCLUSION

Most of the trauma patients who respond to initial fluid replacement do not require surgery. Close monitoring and repeated abdominal examinations (NIMS) can be the main criteria for surgical intervention, although they are not the most reliable techniques in the diagnosis of solid organ injuries in all patients and of hollow organ injuries in conscious patients.

Key Words: Abdominal injuries; accidents, traffic; diagnosis, differential; follow-up studies; hemodynamic processes; injury, blunt; wounds, nonpenetrating/mortality/surgery/ultrasonography.

AMAÇ

Batın yaralanmalarında cerrahi dışı yaklaşımlar; mortalite riskini artırmadan, hastaların cerrahi girişim uygulanmadan tedavisini amaçlar. Bu çalışmada invaziv olmayan tedavi stratejisiyle tedavi edilen hastalar sunuldu.

GEREÇ VE YÖNTEM

Bu çalışmada 1 Haziran 2000 ile 1 Haziran 2001 (invaziv olmayan tedavi yaklaşımı uygulamasının ilk yılı) tarihleri arasında başvuru anında hemodinamik olarak anstabil olan 63 batın travmalı hasta (50 erkek; 13 kadın; dağılım 8-61 yaş) değerlendirildi. Olgular erken cerrahi, geç cerrahive konservatif yaklaşımla tedavi edilenler olmak üzere üç grupta incelendi.

BULGULAR

Başvuru anında instabil 63 künt batın travmalı hasta saptandı. Grup 1 (n=14) ve Grup 2'deki (n=10) hastalar erken veya geç [ortalama 7 saat (2 ile 20 saat) gözlem süresi sonrası] ameliyata alındı. Grup 3 (n=39) hastalarına cerrahi girişim gerekmedi.

SONUÇ

Travma hastalarının çoğu başvuru anında instabil olsalar da başlangıç sıvı replasmanına cevap verirler ve cerrahi tedavi gerektirmezler. Bu hastalarda solid organ yaralanmalarını, bilinci açık hastalarda ise içi boş organ yaralanmalarını gösteren en önemli teknik olmasada yakın monitörizasyon ve tekrarlayan batın muayeneler içeren invaziv olmayan tedavi stratejisi cerrahi girişim gerekecek hastaların seçiminde uygun bir yöntem olabilir.

Anahtar Sözcükler: Batın yaralanması; kaza, trafik; tanı, ayırıcı; izlem çalışması; hemodinamik süreç; yara, künt; yara, penetran olmayan/mortalite/cerrahi/ultrasonografi.

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Trauma is one of today's most serious and expensive health care problems, and it is the most common cause of mortality in young population.[1,2] Blunt trauma caused by traffic accidents, falls, and physical assaults can cause severe abdominal injuries such as solid organ or vascular trauma, which can cause hypovolemic shock and death, and hollow-organ injury, which can cause peritonitis.

Although early detection and treatment of abdominal injuries can decrease mortality and morbidity, such injuries are sometimes difficult to diagnose. Severe trauma patients had traditionally undergone emergency laparotomies in an effort to rule out serious abdominal injuries. However, during the past two decades this approach has been left, because it has been observed that only 10% of all patients with multiple traumas had intra-abdominal injuries.[3] This finding has changed the management of blunt abdominal trauma from a surgical to a conservative management to decrease the rate of non-therapeutic laparotomies. In fact, many studies have documented that a non-surgical approach is safe in patients with severe abdominal injury.[4-8]

Some of the patients with severe abdominal trauma are unstable (hypotension and tachycardia) during their admissions. These patients can also be managed with non-surgical approach, because fluid replacement rapidly stabilizes the condition in 80% to 90% of these patients.[1,9,10] The patient who is best served by early laparotomy is one who cannot be stabilized with initial resuscitation and volume infusion.

However, there is still debate on how to best observe patients with abdominal injuries. Few authors have suggested that non-operative management can be used safely only when it is combined with imaging techniques such as computerized tomography (CT) or ultrasound (USG),[9,11] but even some patients with high-grade hepatic and splenic injuries do not require a surgical intervention and respond to medical therapy.[5,9,11] Failure to diagnose a ruptured hollow viscus remains of great concern during the observation period. No current imaging modality consistently offers a higher degree of accuracy for the diagnosis of these injuries.[12] Thus, the necessity of these imaging techniques may be questionable in patients with blunt abdominal trauma with suspected hollow-organ injuries.

Hemodynamic status and repeated abdominal examinations can be used as good markers to determine the need for surgery in patients with suspected solid-organ injury because it is safe to manage most of these patients non-surgically, unless they are hemodynamically unstable. In addition, patients with hollow-organ injuries exhibit peritoneal signs, which can be detected by the clinician during repeated abdominal examinations. Fortunately, delayed recognition of hollow-organ injury does not increase morbidity unless the delay is greater than 24 hours.[13]

Kartal Training and Research Hospital is a medical center located in the south-eastern region of Istanbul. Almost 30,000 patients are being admitted to the emergency department of this hospital each year, most with trauma injuries.[14] In June of year 2000, the staff surgeons at the 1st General Surgery Service and Emergency Department held a consensus meeting on the management of patients with blunt abdominal trauma and agreed to use a non-invasive management strategy (NIMS), inspired from the development of non-operative management of trauma patients all over the world. Non-invasive management strategy has 3 main components:

1) close monitoring of hemodynamic stability by checking pulse rate and blood pressure;

2) performing abdominal examinations at least every 2 hours;

3) performing a diagnostic peritoneal lavage (DPL) in unconscious patients to rule out hollow-organ injuries. The non-invasive management strategy can be combined with CT or USG according to individual surgeon preference.

Non-invasive management strategy was designed to decrease non-therapeutic laparotomies without increasing mortality rates and questionning the necessity of CT or USG in non-operative management of trauma patients. Therefore, the purpose of this study was to evaluate whether NIMS achieved those goals in hemodynamically unstable patients with blunt trauma during its first year of implementation in our emergency department.

MATERIALS AND METHODS

The medical records of all patients with severe blunt abdominal injuries who were managed at our hospital with NIMS between July 1st, 2000 and

July 1st, 2001 (the first year of NIMS implementation) were retrospectively analyzed. Only those who were hemodynamically unstable (blood pressure below 70 mmHg and pulse rate above 120/min) were included in the study.

According to NIMS, crystalloid solutions (30 ml/kg/h) were immediately administrated via 2 large-caliber intravenous catheters during admission. This amount is approximately 2000 ml per hour in a 70 kg weight adult. If the patient's blood pressure increased and the pulse rate decreased, the patient was considered to have responded to the therapy. These patients were then closely monitored: their blood pressure and pulse rate were checked every 30 minutes during the first 6 hours of admission and then every 60 minutes thereafter. Hemoglobin levels and leukocyte counts were obtained every 4 hours. In addition to a complete examination at admission, a clinician performed an abdominal examination every 2 hours or more often if it was clinically required. All abdominal examinations were preferably done by the same physician. If that was not possible, the clinician who performed the last examination explained the latest results in detail to the new clinician. This intensive observation was continued for at least 24 hours. Although NIMS do not have straight restrictions in clinicians' routine approach, USG and/or CT examinations performed in some patients were decided according to clinicians' preference.

Emergency laparotomy was indicated if a patient did not respond to NIMS, his or her blood pressure or pulse rate became unstable at any time during observation, or if the patient exhibited signs of peritoneal irritation during observation.

All unconscious patients underwent a DPL to rule out hollow-organ injury. Aspiration of more than 50 ml of blood during the DPL did not indicate the need for surgical intervention as long as the patient was hemodynamically stable. However, surgery was scheduled if the DPL analysis revealed fecal contamination or if 50 ml of blood or more was aspirated and the patient became hemodynamically unstable.

The surgeons noticed a decrease in hemoglobin levels and an increase the white blood cell counts, especially when there was not another injury such as osseous fracture or open wound injury that could explain the changes in these measurements, but they never considered an absolute laparotomy indication for surgery in hemodynamically stable patients. Injuries of abdominal solid organs observed with USG or CT alarmed the clinician but did not indicate the need for emergency surgery, unless the patient became hemodynamically unstable or peritoneal irritation findings were present. In addition, each surgeon had the option to stop NIMS any time during the observation period if he/she was unsure about the patient's general medical condition.

Eligible patients were divided into 1 of 3 groups according to the presence or absence of surgical intervention and the timing of the operation. Group 1 consisted of patients who did not respond to resuscitation therapy and therefore underwent urgent surgery immediately after admission. In Group 2, the decision to perform emergency surgery was made during the observation period. Group 3 patients did not require surgery. The following data were compiled and analyzed: patient demographics (age and sex), cause of trauma, concomitant injuries (cranial, thoracic traumas and serious osseous [pelvis, femur, and vertebra] fractures), operative technique and findings, reasons for and rates of non-therapeutic laparotomies and deaths, and the results of diagnostic techniques. The chi-square test was used to compare data between the groups. A p value of less than 0.05 considered statistically significant.

RESULTS

During our study period, 63 hemodynamically unstable patients were managed with NIMS (40 men, median age was 27 years [6 to 61]). Twenty-four of the 63 patients underwent urgent or emergency surgery whereas the remaining patients did not require surgical intervention. Patients' distributions into 3 groups were as follows: Group 1 (n=14), Group 2 (n=10), and Group 3 (n=39).

Table 1 outlines the demographic data, trauma type, and number of concomitant injuries for all groups. There was no statistically significant difference between the groups for demographic data (age and sex) and trauma type. Traffic amlidents were the most common reason for the traumas in our study. Fifty (79%) patients had concomitant injuries, including cranial (n=32, 51%), thoracic

Table 1. Demographics and trauma type in study patients

	Group 1 (n=14)	Group 2 (n=10)	Group 3 (n=39)	*p*
Age	27 (12-60)	30 (8-54)	26 (6-61)	0.87
Sex				0.99
Female	3	2	8	
Male	11	8	31	
Trauma type				0.41
Traffic accident (in-vehicle)	8	3	23	
Traffic accident (out of vehicle)	3	4	8	
Fall	2	2	7	
Trivial	0	1	1	
Crush injury	1	0	0	
Concomitant injuries*	13	7	30	0.43
Cranial	5	2	25	
Thoracic	7	4	10	
Serious osseous fracture (pelvis, femur, vertebra)	5	3	10	

*There was more than one concomitant injury in 3 patients in Group 1, 2 patients in group 2, and 10 patients in group 3.

(n=21, 33%) and critical osseous (n=18, 29%) traumas. No statistical difference in concomitant injuries was observed between the groups. Total number of unconscious patients was 39 (62%) (10 in Group1, 2 in Group 2, and 27 in Group 3).

In Group 1 (n=14), neither USG nor CT was performed because all patients were hemodynamically unstable. A DPL was performed in only 7 of 10 unconscious patients; the remaining 3 patients did not undergo a DPL because urgent surgery was indicated due to hemodynamic instability. More than 50 ml blood was aspirated from the abdomen in each of these patients, but aspirates were not examined microscopically. The presence of hemodynamic instability and surgeons' preference were the indications for surgery in all 14 patients. Two patients had combined solid organ and major vessel injuries (inferior vena cava or superior mesenteric vein). One patient had tears in external iliac artery and vein and the other had retroperitoneal hematoma; these injuries were secondary to pelvic fractures (Table 2). Five patients (36%) died in the perioperative period: Two deaths were related to cranial trauma, 1 death was related to unstable pelvic fracture, and 2 deaths were related to intra-abdominal injury (superior mesenteric vein tear and pancreas amputation in 1 patient, inferior vena cava tear in the other). There were two non-therapeutic laparotomies (14%). In both patients, DPL was performed immediately after the admission during the resuscitation therapy, and more than 50 ml of blood was aspirated from the abdomen. Because they were hemodynamically unstable, exploratory laparatomy was indicated. They also had concomitant injuries including osseous (n=2), thoracic (n=1), and cranial (n=1) fractures. Exploratory laparotomy revealed retroperitoneal hematoma in a patient and grade 2 hepatic rupture in the other.

In Group 2 patients (n=10), a DPL was performed in two unconscious patients immediately after admission. More than 50 ml of blood was aspirated in 1 patient, but neither of the aspirates contained fecal contamination. One of these unconscious patients had high blood alcohol content on admission; a few hours after his normal DPL, he developed peritoneal signs, and exploratory laparotomy revealed hollow organ injury. During the study period, this was the only patient in whom DPL failed to show the intra-abdominal hollow organ injury. Ultrasound was performed in

Table 2. Operative findings, non-therapeutic laparotomies and type of injuries in Group 1 and 2

	Group 1 (n=14)	Group 2 (n=10)	*p*
Injured organs*	12	10	0.16
Solid organ	12	8	
Hollow organ	2	5	
Major vessels	3	0	
Retroperitoneal hematoma	1	0	
Non-therapeutic laparotomy**	2	0	
Type of injury			0.14
Isolated solid organ and/or Vascular injury	12	5	
Isolated hollow organ injury	0	2	
Combined injuries	2	3	

*There were combined solid organ, hollow organ and major vessel injuries in 6 patients; 2 in Group 1, 3 in group 2; ** Retroperitoneal hematoma and grade 2 liver injury did not require surgical management in 2 patients.

3 patients, which showed intra-abdominal fluid in 2 of them but did not reveal any specific organ injury. The indications for emergency surgery were hemodynamic instability (n=4) and peritoneal irritation findings (n=6). The median observation period between admission and surgery was 7 hours (range, 2 to 20). Neither mortality nor non-therapeutic laparotomy was observed in this group.

Group 3 patients (n=39) did not require surgical intervention. Although these patients were hemodynamically unstable at admission, an aggressive resuscitation corrected unstability in an hour in most cases and a non-operative approach, described above in detail was achieved. As mentioned before, CT and USG examinations were done according to clinicians' preferences. A DPL was performed in the 27 unconscious patients, and more than 50 ml blood was aspirated in 5 patients, but none of the aspirates contained fecal contamination. Computerized tomography (n=6) and ultrasound (n=3) revealed grade 2 (n=2) or 3 (n=1) splenic injuries, and grade 2 (n=2) or 4 (n=1) hepatic injuries in 6 patients, but surgery was not indicated because these injuries did not cause hemodynamic instability in these patients. Five patients (13%) died of causes related to cranial trauma in this group.

The operative findings in Groups 1 and 2 are given in Table 2. No statistically significant difference between the groups was observed for the operative findings. The spleen (n=14; 58%) was the most injured organ in our series. The other injured organs were the liver (n=6; 25%), small bowel (n=3; 13%), colon (n=3; 13%), pancreas (n=1; 4%), stomach (n=1; 4%), bladder (n=1; 4%), ureter (n=1; 4%), superior mesenteric vein (n=1; 4%), inferior vena cava (n=1; 4%), external iliac artery (n=1; 4%) and external iliac vein (n=1; 4%). The splenic injuries were managed with splenectomy (n=10), splenorraphy (n=3), or partial splenectomy (n=1). Liver injuries were managed with hepatorraphy (n=3) or partial non-anatomic resection (n=2), and a grade 2 liver injury did not require any treatment. The hollow organ injuries were managed with primary repair (n=7) or resection and end-to-end anastomosis (n=2). The major vessel injuries (n=4) were reconstructed with primary repair. A patient with an injured pancreas could not be managed because the patient died before the reconstructive surgery. No operative management was performed for retroperitoneal hematoma.

The overall mortality rate was 16% (10 of 63 patients), which was mostly related to cranial trauma (n=7, 70% of all deaths). Five patients died in each of Group 1 and Group 3, and no mortality was observed in group 2. No comparison was done within the groups, since the number of deaths related to intra-abdominal injuries was only 3 (all in

group 1) which were considered unpreventable. These 3 patients were in Group 1 and urgent laparotomies were indicated during the resuscitation therapy immediately after their admissions, but all died of causes related to hypovolemic shock secondary to intra-abdominal injuries (n=2) or unstable pelvic fracture (n=1). Damage control procedures were not reasonable in these patients, since they died immediately after laparotomy. The non-therapeutic laparotomy rate was 8% (2 of 24 patients).

DISCUSSION

There has been a marked trend toward non-operative management of patients with blunt abdominal trauma in an aim to lessen the number of non-therapeutic operations without increasing mortality. The selection of non-operative management candidates is still unclear and is an important issue that affects the outcome of this approach. In our study, there were no statistical differences between the demographics, trauma types, or concomitant injuries of the 3 patient groups. In our opinion, these variables cannot help determine the trauma patients who will have the most beneficial results from the non-operative treatment.

Our study evaluates the effectiveness of our NIMS program in patients with severe trauma. In these patients, hypovolemic shock secondary to solid organ or vascular injuries is the main point of concern, which is one of the most common causes of abdominal trauma-related deaths. It was suggested that initial blood pressure and pulse rates do not help predict the need for surgery in patients with solid-organ injuries, and this was confirmed with our study.[1] In our study, all patients were hemodynamically unstable during admission, but in most cases, their general conditions improved after a resuscitation procedure that included aggressive fluid replacement. Actually, it is unclear how long this "aggressive fluid replacement" will continue. It is obvious that it may differ from patient to patient. A longer period may be preferred in a patient with retroperitoneal hematoma, and an urgent laparotomy may be logical in a case with solid organ injury. Thus, the period of resuscitation may be decided according to the primary injury, and omitted if an obvious life-threatening situation occurs. However, in our opinion, the initial blood pressure and pulse rate during admission should not be considered as an indication for urgent surgery, but clinicians should closely observe the unstable patient during initial resuscitation period. In addition, recent studies revealed that an excessive fluid resuscitation may aggravate bleeding, thus it is important not to cause hypertension during this period.[15] If the patient does not respond to this aggressive therapy, urgent laparotomy should be indicated during or immediately after the resuscitation procedure.

Hollow organ injury is the second point of concern during the non-operative management of blunt abdominal trauma because it may cause peritonitis and subsequently increase mortality and morbidity in misdiagnosed patients. Hollow organ injuries are observed in 0.7% of all blunt abdominal trauma admissions, and they occur in 5% to 15% of patients with serious abdominal traumas.[16,17] In our study, hollow organ injuries (n=8) were observed in 11.1% of 63 patients with severe abdominal injuries and 33.3% of 24 patients, who had surgical intervention. If hollow organ injuries are associated with solid organ injuries that require surgery, they can be identified during laparatomy. But it is difficult for the clinician to diagnose isolated hollow organ injuries, which are observed in almost 60% of all hollow organ injuries (but only 20%, 2 of 10 patients in our study).[13] Fortunately, a delay in recognizing hollow organ injuries does not increase morbidity if the duration between the admission and repair is not greater than 24 hours.[18] We believe that the abdominal findings secondary to intestinal spillage may alert the clinician to the need for an emergent laparotomy during the close observation with repeated abdominal examinations unless the patient is not conscious because of a brain injury, a significant blood alcohol level, or organic brain disease. In our series, signs of peritoneal irritation were observed in 6 patients in Group 2, and hollow organ injuries were observed in 5 cases during subsequent laparotomies.

In the literature, CT is generally recommended in trauma patients to specify the intra-abdominal injury.[1] In addition, some advocated that non-operative management could be used safely only when it was combined with CT or USG.[9,11] In our opinion, CT or USG is not a necessity in blunt trauma patients but may be preferred if it is available.

First of all, surgery is not necessary in most patients whose CT or USG results verify hepatic or splenic injuries unless they are hemodynamically unstable. A non-operative approach has been reported in 14 of 18 patients with severe hepatic or splenic injuries identified with CT.[1] Similarly, in our study, CT and/or USG revealed splenic and hepatic injuries in 6 patients who did not require surgical intervention. Additionally, neither CT nor USG is able to show most of the hollow organ injuries, which may indicate the need for urgent surgery in hemodynamically stable patients. Furthermore, hemodynamic stability may not be accurately observed while CT examination is being done. Thus, we believe that unless CT or USG is available, patients with abdominal injuries can be observed with close monitoring of blood pressure and pulse rate, which are accurate indicators of hemodynamic stability, and with repeated abdominal examinations, which may reveal the presence of hollow organ injuries. In addition, CT and USG examinations may help the surgeon at the time of operation even for the decision of damage control surgery such as hepatic packing.

In our opinion, NIMS has acceptable rates of mortality. In our study 10 of 63 patients died 2 because of severe abdominal injury (3%). Urgent laparotomies were indicated for both of these patients shortly after their admissions during the resuscitation therapies, to which they did not respond. No intra-abdominal injury related mortality was observed in the patients who had delayed laparotomies or non-operative management.

Non-invasive management strategy also was associated with a low rate of non-therapeutic laparotomy. Of the 24 laparotomies performed, only 2 (8%) were non-therapeutic. The 2 patients had had cranial, thoracic, or osseous fractures. Both of the non-therapeutic laparatomies were indicated during the initial resuscitation periods after aspirating more than 50 ml blood during DPL in both patients. In our opinion, these observations suggest that NIMS is an effective and safe procedure in even severe abdominal trauma patients who are hemodynamically unstable during admission.

Our main concern with NIMS is that it is not reliable in unconscious patients with suspected isolated hollow organ injuries. During our consensus meeting, we predicted that DPL would help us diagnose hollow organ injuries. In practice, the microscopic analysis of DPL aspirate confirmed the absence of hollow organ injuries in 28 of 29 patients in Groups 2 and 3, and it failed to do so in only 1 patient who subsequently developed peritoneal signs. The operation revealed a hollow organ injury in this patient. In our opinion, peritoneal irritation findings should be the main criteria for the surgical intervention in conscious patients who are suspected to have isolated hollow organ injuries. In unconscious patients, a DPL may help to eliminate hollow organ injuries, but the clinician should continue observing the patient even if the DPL is negative.

In our opinion, the DPL is not an effective indicator for surgery in patients with suspected solid organ injury. More than 50 ml blood was aspirated from the abdomens of 2 patients' who had non-therapeutic laparotomies and in 5 patients in Group 3 who did not require surgical intervention. A DPL is routinely used in unconscious cases in our study, however since none of the patients with a positive DPL required surgery; we, now, believe that DPL may not be indicated in this kind of cases. These patients may rather be followed with close monitoring of laboratory findings such as white blood cell count, fever and C-reactive protein.

In conclusion, the initial resuscitation with aggressive fluid replacement is essential in the management of patients with severe blunt trauma. Blood pressure and pulse rate can be the main criteria for surgical intervention during the observation period of the patients with solid organ injuries. Repeated abdominal examinations are helpful in determining hollow organ injuries in conscious patients. A DPL may be helpful in unconscious patients with suspected isolated hollow organ, but even if it is negative, close observation should be continued.

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