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Retroperitoneal Haematoma – Still a Medical Challenge for Abdominal Trauma

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Abbreviations:
CT: Computed Tomography,
FAST: Focused Assessment with Sonoghraphy for Trauma,
ISS: Injury Severity Score,
NOM: Non Operative Management,
DC: Damage Control,
IVC: Inferior Vena Cava,
MOF: Multiorgan Failure,
WTA: Western Trauma Association,
EAST: Eastern Association for the Surgery of Trauma,
RT-PCR: Reverse Transcription Polymerase Chain Reaction,
TEG: Thromboelastography,
ROTEM: Rotational Thromboelastometry,
REBOA: Resuscitative Endovascular Balloon Occlusion of the Aorta,
ICU: Intesive Care Unit.

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Rezumat

Hematomul retroperitoneal – încă o provocare medicală în trauma abdominală

Introducere: Studiul prezintă o experienţă personală a unui Centru de Traumatologie Nivel I şi încearcă să concluzioneze asupra atitudinii medicale optime pentru pacienţii cu hematom retro-peritoneal, subiect încă controversat pentru traumatologi.
Material şi Metodă: Se prezintă o analiză retrospectivă a 22 de cazuri de hematom retroperitoneal posttraumatic internate la Spitalul Clinic de Urgenţă Bucureşti în perioada septembrie 2018 – august 2021 (inclusiv perioada pandemiei de Covid-19).
Rezultate: Pacienţii (predominanţă masculină, vârsta medie 43, ISS mediu 23), au beneficiat de management non-operator la internare în 10 cazuri (45%) - cu o rată de eşec de 4/10 din cauza sângerării recurente din leziuni splenice şi sângerare continuă din leziuni ale vaselor mezenterice. Scanarea CT (73% - 16 cazuri) în termen de 1 oră de la internare şi intervenţia chirurgicală de urgenţă au fost necesare pentru 12 cazuri (55%). 2 pacienţi au beneficiat de angioembolizare la internare. Atitudinea conservatoare pentru hematomul retroperitoneal a fost adoptată în 72% din cazuri. Mortalitatea totală: 18% (4 pacienţi, ISS mediu 36), dintre cele 82% cazuri de poli-traumatism.
Concluzii: Algoritmul de tratament este adaptat fiecărui caz de hematom retroperitoneal, dar următoarele secvenţe sunt obligatorii: transport rapid la Centrul de Traumatologie Nivel I cu ajutor medical, resuscitare corectă, imagistică imediată relevantă (CT), intervenţie chirurgicală de urgenţă înainte de angio-embolizare (pentru pacienţi instabili hemodinamic) sau

după aceasta, stabilizarea în Secția Terapie Intensivă a pacientului şi apoi repararea definitivă a leziunilor. Cu toate acestea, mortalitatea rămâne ridicată.

Cuvinte cheie: hematom retroperitoneal, traumatism abdominal, chirurgie de urgență

Abstract

Introduction: The study is presenting a personal experience of a Trauma Centre Level I and is try to conclude on optimal medical attitude for patients with retroperitoneal hematoma, still a controversial topic for traumatologists.

Material and Method: A retrospective analysis of 22 cases of post-traumatic retroperitoneal hematoma admitted on Bucharest Emergency Hospital between September 2018 – August 2021 (including time of Covid-19 pandemic), is presented.

Results: The patients (males predominance, mean age 43, mean ISS of 23), benefited of non-operative management on admission for 10 cases (45%) – with a failure rate of 4/10 due to recurrent bleeding from spleen injuries and continuous bleeding from mesenteric vessels lesions. CT scan (73% - 16 cases) within 1 hour from the admission and emergency surgery were necessary for 12 cases (55%). 2 patients benefited of angioembolization on admission. Conservative attitude for retroperitoneal hematoma was adopted for 72% cases. Over-all mortality: 18% (4 patients, mean ISS of 36), among 82% polytrauma cases.

Conclusions: Algorithm of treatment is adapted to every case of retroperitoneal hematoma but the following sequences are mandatory: rapid transportation to Trauma Centre Level I with medical help, correct resuscitation, immediate relevant imagistic (CT scan), emergency surgery prior to angioembolization (for hemodynamic instable patients) or after it, ICU stabilization of the patient and then definitive repair of the injuries. Despite all, mortality remains high.

Key words: retroperitoneal hematoma, abdominal trauma, emergency surgery

ntroduction

Abdominal trauma is still representing a corner stone for an emergency surgeon due to possible complex organ injuries, most of the cases being associated. Both on penetrating and blunt abdominal trauma, retroperitoneal hematoma is always a sign of gravity for this type of trauma. Accumulation of blood in the retroperitoneal space can have multiple sources: damage of retroperitoneal solid organs (kidneys, adrenals, and pancreas) or cavitary organs (duodenum, ascending or descending colon, and inferior rectum), injuries of the retroperitoneal great vessels (inferior vena cava, aorta, portal vein, renal vessels, celiac trunk and its main branches, iliac vessels) as well as injuries of small retroperitoneal vessels (lumbar vessels, mesenteric vessels) – this is the reason of difficulty for diagnosis and treatment of a retroperitoneal bleeding (1). Due to the significant amount of blood loss, it is common that retroperitoneal hematoma is representing an emergency situation for a trauma patient, sometimes life-threatening (2) if not the patient is dying at the scene of accident. Rapid transportation of the patient to a Trauma Centre Level I is mandatory – complex medical resources are necessary to be available from the first beginning of the professional help and emergency practice expertise can save the life of such trauma patients, especially for polytraumatised patients. The idea of critical running time for such patients and the necessity of rapid

diagnosis and adequate treatment of the retroperitoneal bleeding using experienced medical retrieval teams and fast aeromedical transport to a fully equipped Trauma Centre Level 1 ready to assure an immediate and complete medical management for these patients, are well sustained by medical literature (3).

Given the above, it seems mandatory for a Trauma Centre Level I - like Emergency Hospital Bucharest - to periodically review the medical aspects on post-traumatic retroperitoneal hematoma, taking into consideration not only daily life conditions and last medical literature comparisons but also the improved access to last medical devices and treatment (including algorithms) in order to reach the best medical solutions for these patients.

Material and Method

A retrospective analysis of 22 cases of trauma patients with retroperitoneal hematoma admitted to Emergency Hospital Bucharest in the last 36 months (September 2018 – August 2021) is presented. The recorded data have been compared to medical literature available after on-line research using terms "retroperitoneal hematoma", "trauma surgery", and "abdominal trauma".

Retrospective descriptive analysis of the recorded data has been used for presenting our personal experience.

Results

Among these 22 patients, it is interesting to observe that only 9 patients (9/22) have been admitted to our hospital during national COVID-19 pandemic time (starting March 2020 up to August 2021) but none of them has been identified as COVID-19 positive (after RT-PCR on admission).

The group of study noticed male prevalence (17 men vs. 5 women) with an average age of 43.4 (ranges 19 – 76).

Some cases have been transferred from another hospital - 9 patients (9/22) because of the expertise level of Emergency Hospital from Bucharest – 5 cases (5/9) being transported to our hospital by medical helicopter. The aeromedical transport was also available for 2 more patients directly from the crush scene, patients with hemodynamically instability. 4 patients (4/22) have arrived to the hospital by private transport (no medical support) and the rest of them (11/22) by mobile Intensive Care Unit ambulances.

Speaking of mechanism of trauma, the following data were recorded: car accidents – 17 cases (17/22) (Driver – 6 of 17, occupant – 4 of 17, pedestrian – 4 of 17, motorcyclist – 3 of 17), falling – 4 cases (4/22), explosion – 1 case (1/22).

Among the 22 cases, 8 (8/22) required mechanical ventilation with oro-tracheal intubation – Index Severity Score (ISS) of median 35 (ranges 13 – 50), five of them (5 of 8 cases) being hemodynamically instable. Most patients (16/22) presented various associated orthopedics trauma (2 cases with major orthopedics trauma and ISS 22, respectively 48; 10 cases with moderate orthopedics trauma and average ISS of 30; 10 cases with minor or none orthopedics trauma) and associated craniocerebral trauma (3 cases with severe craniocerebral trauma and average ISS of 32; 2 cases with moderate craniocerebral trauma and average ISS of 30; 17 cases with minor or no craniocerebral trauma). Speaking of all, we noticed 4 cases with only abdominal trauma (4/22) and average ISS of 15 and 18 cases (18/22) with polytrauma (association of abdominal trauma with craniocerebral trauma – 3 cases with an average ISS of 10; association of abdominal trauma with orthopedics trauma – 3 cases with an average ISS of 16; association of abdominal trauma with craniocerebral trauma and orthopedics trauma – 12 cases with an average ISS of 31) – all these patients presented retroperitoneal hematoma on admission.

Only one patient of 22 (1/22) benefited from Focused Assessment with Sonography for Trauma (FAST) scan on admission and a 3 cm retroperitoneal hematoma has been noticed

due to minor spine injury (no abdominal viscera damaged, minor orthopedics trauma and ISS of 8) – the patient had a non-operative management attitude and re-evaluation by computed tomography scan (CT scan) after 48 hours showed smooth clinical evolution for resorption of the retroperitoneal hematoma and discharge of the patient after 8 days.

Five patients (5/22) benefited from conventional ultrasound examination of the abdomen and only for 3 of them it was adopted a non-operative management (NOM), and one of these three being operated later than 24 hours for delayed 3-degree rupture of the spleen (96 hours from the admission time, after CT scan re-evaluation – failure of NOM); for the last 2 patients, abdominal echography indicated urgent laparotomy and ruptures of mesenteric vessels were identified and hemostasis has been performed within 5 hours from admission.

Most patients benefited of whole-body CT scan within 1 hour from admission – 16 cases (16/22). Among them, 7 patients were hemodynamically instable at the moment but Advanced Trauma Life Support of Emergency Department medical stuff and proximity of the device (24 hours per day available) offered the possibility for such a crucial investigations for treatment decisions.

A short presentation of the therapeutically attitude for all 22 cases is to be found in the *Table 1.*

Table 1.

S – Surgery; NOM – Non-operative management, (* = failure), Damage–control DC, Conservative C, Evacuation E

Case no.	ISS	On admission	Organ Injury Scale	Emergency Surgery	Late Surgery (after 24 hours)	Retroperitoneal hematoma (cm - CT)	Death Yes No
1	35	S	Liver-3 Spleen-3 Kidney-1	Splenectomy Packing Liver	De-packing	5 C	Yes (po1)
2	13	NOM*	Spleen-3 Kidney-2	-	Splenectomy (after 96 h)	3 C	No
3	50	S	Liver-3 Kidney-2	DC	De-packing	2 C	No
4	22	S	Spleen-4 Pancreas-1 Kidney-1	Splenoraphy Orthopedics	-	5 C	Yes (po26)
5	5	NOM	Spleen-1 Kidney-1	-	-	6 C	No
6	29	S	Spleen-3 Kidney-3	Splenectomy	-	4 C	No
7	29	S	Liver-4 Spleen-2 Kidney-3	Splenectomy Liver Packing	De-packing	4 C	No
8	13	NOM	Liver-1 Spleen-1 Kidney-2	-	-	6 C	No
9	16	S	Spleen-2 Kidney-5	Splenectomy Nephrectomy	De-packing retroperitoneal	15 E	No
10	34	NOM	Liver-2 Mesentery-1	-	-	4 C	No
11	27	S	Spleen-2 Mesenter-2	Splenectomy Hemostasis mesentery	-	5 C	No
12	5	NOM*	Mesenter-1	-	Laparoscopic hemostasis mesentery (after 72h)	4 E	No
13	41	S	Spleen-5 Mesenter-1	Splenectomy	-	3 E	Yes (po8)
14	5	NOM	Spleen-2 Mesenter-1	-	AngioEmbolization Spleen (after 24h)	4 C	No
15	4	S	Mesenter-1	Evacuation hematoma	-	4 E	No

Table 1. (continuation)
S – Surgery; NOM – Non-operative management, (* = failure), Damage–control DC, Conservative C, Evacuation E

Case no.	ISS	On admission	Organ Injury Scale	Emergency Surgery	Late Surgery (after 24 hours)	Retroperitoneal hematoma (cm - CT)	Death Yes No
16	11	S	Mesenter-2	Evacuation hematoma	-	5 E	No
17	5	NOM	Mesenter-1	-	-	3 C	No
18	38	S	Spleen-1 Pancreas-1 Iliac vein-3	DC Suture iliac v.	De-packing	7 E	No
19	48	NOM*	Liver-2 Spleen-3 Kidney-1 Pelvic fracture	-	Splenectomy (after 20 h)	3 C	Yes (po1)
20	22	NOM*	Liver-2 Spleen-1 Spine	-	Splenectomy (after 144 h)	4 C	No
21	8	NOM	Spine	-	-	3 C	No
22	45	S	Spleen-3 Pancreas-2 Spine	Splenectomy	-	6 C	No

It is also interesting to notice that Diagnosis Peritoneal Lavage (usually performed on the operating table some years ago in our hospital) has not been used anymore for this group of 22 patients.

Emergency angiography has been performed for 2 patients (2/22):

- an 48 year old male, ISS 38, transported by helicopter to our hospital, intubated and hemodynamically instable, with 3-degree injury of the liver and 3-degree injury of the spleen, and 1-degree injury of the kidney, 5 cm retroperitoneal hematoma for whom the emergency open surgery performed splenectomy and liver packing for temporarily hemostasis, postoperatively angiography with angio-embolization (24 hours after surgery) followed by massive bleeding from hepatic hilum vessels (probably due to failure of the packing compressions) and death of the patient at 48 hours from the admission, despite administration of 15 units of blood transfusion (*Fig. 1*).
- an 19 year old male patient, after falling from 3-4 meters high, coming with private transport to the hospital, hemodynamically stable, ISS 5, for whom emergency CT scan showed 2-degree injury of the spleen and a 4 cm retroperitoneal hematoma due to small laceration of the mesentery vessels; NOM has been adopted for this case and, after 20 hours from admission, a repeated CT scan announced continuous bleeding from the spleen – emergency angiography and selective angio-embolization of the inferior pole of the spleen has been performed; 2 units of

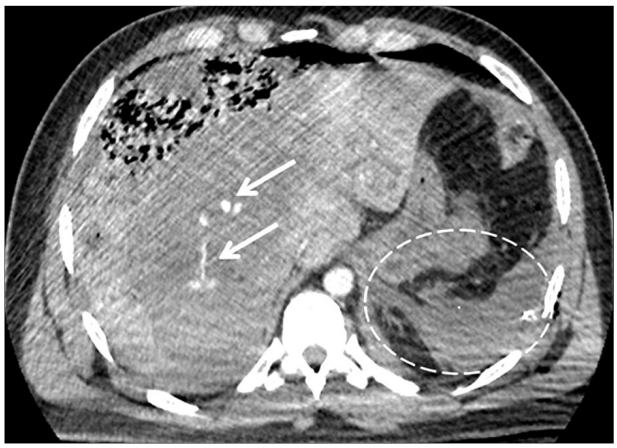

Figure 1. Active bleeding after liver packing (white arrows); retroperitoneal hematoma (dotted white circle).
(Emergency Clinical Hospital – personal collection)

blood transfusion were necessary and full recovery of the patient with discharge after 5 days was noticed (CT scan re-evaluation after 3 days from angioembolization: no more bleedings).

A special case should be presented: an 68 year old female, pedestrian victim of an accident, with ISS 48, with 2-degree injury of the liver, 3-degree injury of the spleen, 1-degree injury of the kidney, moderate craniocerebral trauma and C2 Tile classification pelvic fracture with 3 cm retroperitoneal hematoma, was operated on admission for pelvic external fixation; no surgery for spleen and liver injuries on admission but after 20 hours splenectomy was necessary for continuous bleeding; despite Intensive Care Unit (ICU) advanced postoperative therapy (including 8 units of blood transfusion), death was recorded after 24 hours from splenectomy (*Fig. 2*).

Finally, 4 patients died (mortality rate 4/22): median age 52 year old (23 – 70), ISS 36 (average), 3 patients with severe polytrauma (one patient with pelvic fracture and severe craniocerebral trauma and triple abdominal viscera injuries, for whom NOM failed within 24 hours of ICU treatment; two cases – ISS 41, respectively 22, with emergency surgery dedicated to spleen injuries in a polytrauma context and loss of life after 8 days (see *Fig. 3*), respectively 26 days of ICU treatment including blood transfusion up to 27 units) and 1 case of an abdominal trauma (with liver, spleen and kidney involvement and failure of liver embolization).

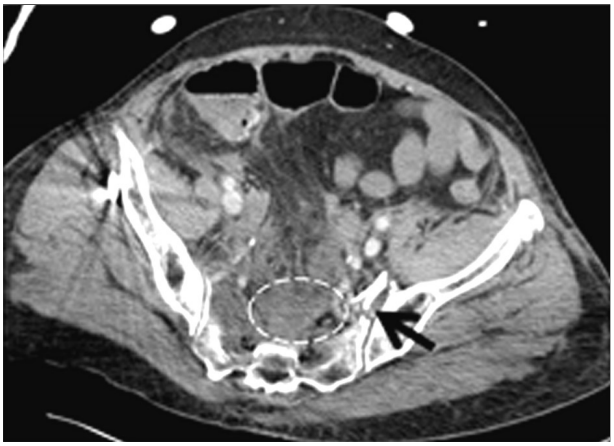

Figure 2. C2 Tile Classification pelvic fracture (black arrow) with retroperitoneal hematoma (dotted white circle).
(Emergency Clinical Hospital – personal collection)

Discussions

Several aspects should be taken into discussion for a topic like abdominal trauma with retroperitoneal hematoma, looking to that recent experience of Emergency Hospital from Bucharest.

Prehospital management of abdominal trauma, especially for polytrauma patients, should be focused on rapid transportation of the victim to an experienced Trauma Centre. On the other hand, it is well known that many of trauma patients are dying at the scene not reaching the hospital, despite the newest performances of emergency medical response teams – more than that, half of those who reached hospital with heart beating are lately dying due to significant bleeding of multiple system organ failure consequence of severe trauma, despite advanced therapeutic measures available in a ICU dedicated to trauma victims (4). It is interesting to observe that our study is presenting four cases of polytrauma patients (almost the fifth part!) brought to our hospital by private transport with no medical support during the time of movement from the accident scene – this is an alarm sign for improvement the chances

Figure 3. Retroperitoneal hematoma between the pancreatic tail and splenic hilum (dotted white circle).
(Emergency Clinical Hospital – personal collection)

for such patients in the prehospital time, regarding the access to proper and immediate medical measures and the diminishing the critical time up to adequate help for diagnosis and treatment. Although the time up to the hospital could be relatively short by private transport, the polytrauma patient will never have the possibility of administration for blood products or tranexamic acid (used for active bleeding control) or even proper medical measures to maintain low values for blood pressure prior to adequate hemostasis before clot rupture provoked by transport movements (6) – these are medical gestures assuring good results for a prehospital time of these patients having an on-going bleeding after trauma, along with decreasing time for transport itself (using medical dedicated helicopter). Developing the prehospital medical care for trauma patients and carrying them as soon as possible to experienced Trauma Centre Level I seems to be the proper way to improve the chances for survival for these patients.

Discussing the recorded data in our study, we emphasize the predominance of car accidents and accidental fallings despite of gunshots and violence aggressions as mechanism for this type of trauma – the consequence is blunt trauma for abdominal viscera in comparison with penetrating trauma (usually damaging great vessels of the retroperitoneal space, a much severe condition): high-degree injuries are found, multiple viscera can be usually involved, hemodynamically instability is often tough to be corrected and surgical treatment can hardly solve the problems immediately for such blunt lesions. Among them, blunt trauma of the duodenum it is hard to be diagnosed and this is why the mortality rate is high – 5.3% - 30% (Santos et al. cited by 6).

On hospital admission, the patient with abdominal trauma and retroperitoneal hematoma – usually a polytrauma patient – should be treated as an emergency surgical case from the beginning.

On a rapid clinical examination of this type of patient having an injury of Inferior Vena Cava (IVC), a bluish bulge of the right side of the patient can be noticed and the diagnosis of a retroperitoneal hematoma can be highly suspected (7). A special attention should be given to the patients having pelvic fractures, especially for elderly patients who can rapidly develop hemorrhagic shock despite a low-energy mechanisms of injury (8). For this category of patients, also a rupture of corona mortis during the time of a pubic ramus fracture can be taken into consideration because a potential of life-threatening situation (8). That's why, The Western Trauma Association (WTA) algorithm for the management of pelvic fractures with haemodynamic instability (published in 2008) sustained the necessity of multidisciplinary team involving trauma surgeons, orthopedic surgeons, interventional radiologists, plastic surgeons, urological surgeons, wound-care nurses, and rehabilitation physicians to approach the polytraumatised patient (9,10). We can say that Emergency Hospital from Bucharest is also counting in this multidisciplinary team the anesthesiologist-intensive care doctors, cardio-thoracic surgeons, Ear-Nose-Throat doctors and oro-maxillofacial surgeons, and neurosurgeons. Despite the complexity of the multidisciplinary team involved in a polytrauma case with pelvic fracture and hemodynamic instability, the optimal management is still controversial, and its mortality rate can reach 50% (11). Anyway, patients with pelvic fracture have a high rate of associated injuries – 12% to 62% (12). Over 16% of patients with pelvic fractures have at least one associated injury (Demetriades D., et al. cited by 12). The most commonly injured structures are intra-abdominal, with the liver, spleen, and kidneys occurring most often (12). In comparison, according to the Eastern Association for the Surgery of Trauma (EAST) Hollow Viscus Injury Study (2003), the small bowel is the most commonly injured organ for an abdominal blunt trauma, followed by the colon, duodenum, stomach, and appendix (14). A recent opinion (2019) is that massive hemorrhages in retroperitoneal space and endopelvic fiber are frequently coming with

the damage of the great endopelvic vessels, presacral and perivesical venous plexuses, and major vessels of the spongy pelvic bone (14). In 2006, Dyatlov and his colleagues demonstrated that for an undamaged pelvis, the retroperitoneal space may contain 4 liters of liquids under pressure and for a fracture of pelvic ring, the amount of liquid is 20 liters for open retroperitoneal space and laparotomy (Dyatlov MM cited by 14). In the same time, according to the Russian researchers, „pressure in pelvis that is caused by the retroperitoneal hematoma can be an obstacle only for stopping the venous hemorrhage in pelvic area since the levels of central venous pressure do not exceed 120 mmHg. At the same time retroperitoneal hematoma cannot be an obstacle for the further development of arterial endotissual hemorrhage, since the pressure in its cavity does not exceed 150 mmHg and the minimal values of systolic blood pressure are around 70 mmHg (952 mmAq). Simultaneously, retroperitoneal hematoma blocks blood outflow through the lower cava and even serves as «venous tourniquet» which only increases the blood pressure" (14).

It is important to remember that, because of the risks of traumatic and hemorrhagic shock, the patients can rapidly develop acidosis, coagulopathy, or hypothermia (6), a triad which dramatically decrease the rate for survival. According to this danger, it is mandatory to remember that hemoglobin or hematocrit levels are not sensitive for identifying acute traumatic hemorrhage but serum lactate and base deficit can be used to monitor resuscitation (Coccolini F., et al.; Rossaint R., et al. cited by 12) which will include minimum amount of crystalloid infusion but blood products and tranexamic acid (5) under strict surveillance of Thromboelastography (TEG) or Rotational Thromboelastometry (ROTEM) if available (15).

Most of medical literature is consensual agree that, along with (and beginning with!) a careful physical examination of the traumatized patient, a contrast-enhanced CT scan is mandatory to identify the source of bleeding when we are dealing with a polytrauma patient or an abdominal trauma with a high suspicion of retroperitoneal hematoma (16). In stable patients, CT scanning shows 86% sensitivity and 88% specificity in diagnosing blunt hollow viscus injury when performed with intravenous contrast, compared with 53% sensitivity and 69% specificity in a diagnosis by physical examination (6). For pelvic trauma, increasingly detailed and rapidly acquired CT scan imaging for improved patient selection is a must do in the management of these patients (17). The same, contrast-enhanced CT scanning is necessary to identify also lumbar arteries injuries, an unusual cause of bleeding after blunt trauma (2). Speaking about the Emergency Hospital from Bucharest group of study, 14 of the patients (14/22) have been CT scanned within 1 hour from the moment of their entrance in the hospital (6 of them even in the first 30 minutes), despite the fact that 6 patients among these 14 were stable hemodynamically but with blood hypotension. Even hemodynamically instable patients (3 cases) have been CT scanned but after 1.5 - 4 hours from their entrance in the hospital, after volemic resuscitation and under strict supervision of the Basic Life Support resuscitation team. Finally, all the studied patients in our group benefited from imagistic evaluation by CT scan later on (including repeated re-evaluation) except one patient for whom conventional ultrasound examination of the abdomen showed laceration of mesenteric vessels with retroperitoneal hematoma and decided transfer of him into operating room and emergency surgery. That is proving the importance of a CT scan device all-time available for an Emergency Hospital.

When the CT scan is clearly evidence for an on-going arterial bleed, it is recommended that the patient should go directly for angioembolization - angioembolization is successful in 85% to 100% of cases (18). There are authors claiming that angioembolization within 90 minutes of arrival to the hospital had improved survival rates (Balogh Z., et al. cited by 12). Also, angioembolization can be repeated in patients with continued hemorrhage and

hemodynamic instability after first embolization (12). Some trauma doctors emphasized that angioembolization should be performed prior to surgery, being much more likely to expose an arterial bleeding by this approach than an open surgical maneuver over a retroperitoneal full of blood space (12). Complications for angioembolization – as are described: hematoma, pseudo aneurysm, dissection, or thrombus – are less than 5% (12). Other authors are also describing arteriovenous fistula or dissection, infection, and lower limb ischemia (19,20). Current evidence, including randomized clinical trials, supports that angioembolization is a safe life-saving technique (21). Our experience showed one successful case of angioembolization of a 2-degree injury of the spleen but also a failure of embolization of a 3-degree liver injury with massive re-bleeding from a branch of right hepatic artery after 24 hours from damage-control packing (probably cause of re-bleeding: inadequate compression of the packing over hepatic hilum). For vessels that cannot be safely embolized, such as the common or external iliac arteries, temporary balloon occlusion buys time for subsequent stent graft deployment or surgical management with open repair (22). It is also important to underline the trend of Emergency Hospital from Bucharest surgical team to replace splenoraphy for spleen injuries with non-operative management including selective angioembolization of the spleen since more than 10 years ago (23).

Treatment: Regarding the therapeutically attitude over the retroperitoneal hematoma after abdominal trauma in our group of study, we can comment that the rule was for conservative treatment, no matter of ISS of trauma: most of the cases had no evacuation of retroperitoneal hematoma but "no-touch" technique during the time of surgery or according to the non-operative management. Opening the retroperitoneal space with no identification of the bleeding source (often damaged lumbar arteries, already retracted) is increasing the chances for further bleeding, sometimes uncontrollable leading to the death of patient (24).

The patients with hemodynamic instability (systolic blood pressure less than 90 mmHg) with imagistic evidence of intra-abdominal injuries should be directly referred to operating room for on-table resuscitation and emergency laparotomy (11). From this point of view, it is important to frame our routinely attitude regarding such cases: patient with abdominal trauma and 2-degree injury of the spleen and 5-degree injury of the kidney, with 15 cm retroperitoneal hematoma (showed on CT scan performed within 30 minute from the entrance in the hospital), has been operated after 1 hour from admission, splenectomy being performed by open laparotomy and conservative attitude for retroperitoneal hematoma along with kidney's lesion; after 48 hours CT scan re-evaluation of a continuous retroperitoneal bleeding requiring redo surgery and nephrectomy. These all surgical steps were possible for a hemodynamically stable young (35 year old) patient with no polytrauma but abdominal injury after accidental falling (*Fig. 4*).

Conservative treatment of the retroperitoneal hematoma due to a severe injury of the kidney was not possible till the end, so surgical ablation of the damaged retroperitoneal viscera was necessary. Not always "no-touch" technique regarding retroperitoneal

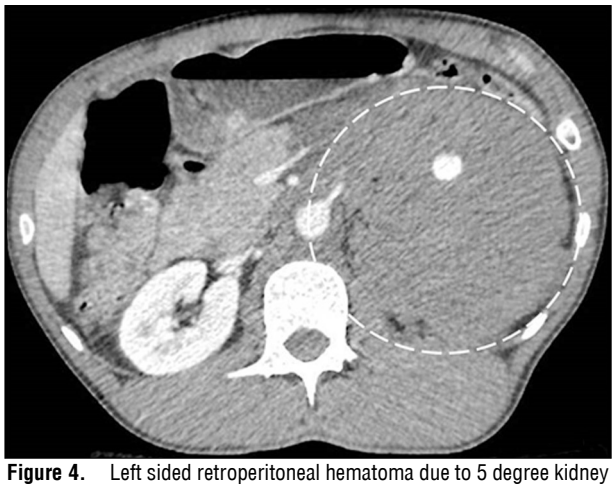

Figure 4. Left sided retroperitoneal hematoma due to 5 degree kidney injury (white dotted circle).
(Emergency Clinical Hospital – personal collection)

hematoma is a success but clinical and imagistic re-evaluation of the patient by the initial trauma surgeon is enough to find the proper treatment for such a patient, with full recovery. And this is an important rule to be underlined for trauma patients: attentive follow-up of clinical evolution of the case by the same initial surgical team.

An important percentage of NOM (Non-operative Management) at the admission of the trauma patients has been recorded in our study – 10/22 – and this is defining nowadays medical attitude based on correct and rapid diagnosis of the injuries and closer medical surveillance for critical hours. Failure of the NOM (4 cases of 10) is due to high-degree splenic injuries (3 or 4) – 3 cases and only one time for a mesenteric vessels trauma, no matter what ISS has been allocated to that patients. One more time, it is demonstrated that trauma patients are unpredictable and closer follow-up for these category of victims should be a strict rule for a trauma surgeon.

Damage-control concept is to be used in order to decrease the initial time of surgery on arrival to stabilize the patient's hemodynamic status and to gain time for resuscitation – preperitoneal packing or simple hemostasis are surgical gestures to be rapidly performed by a trauma surgeon. Later on, when the patient is becoming stable after complex ICU resuscitation, the final repair of the damages is allowed. Patients that are hemodynamically stable or "borderline" can be safely taken for definitive repair within 24 hours of injury (12). For polytrauma patients, post-injury complication rates are increased if definitive repair is completed within four days of injury (12). Complications decreased when surgery was delayed until six to eight days post-injury (Pape HC., et al. cited by 12), that's why it is recommended to wait at least four days until definitive repair (12).

Laparoscopic approach for retroperitoneal hematoma is a brave medical attitude and is recommended only for selected cases – first of all, hemodynamic stable; secondly, usually as an explorative laparoscopy for establishing a more precise diagnosis than as a repair technique. Recent medical literature describes a trauma case with a duodenal rupture in a children which has been fixed by laparoscopic approach (25). For our group of patients, only one case benefited of diagnosis of mesenteric vessels bleeding after blunt abdominal trauma by explorative laparoscopy and conservative treatment has been applied regarding the retroperitoneal hematoma.

We recorded a mortality of 4/22 cases, which is according to the literature average data, regarding the ISS median score of 23 (ranges 4–50), the complexity of the cases (18 of 22 patients were polytrauma patients) and an mean age of 43 year old (ranges 19–79).

A serious condition regarding the retroperitoneal viscera trauma is regarding IVC injuries which are associated with high mortality - Glasgow Coma Scale, the level of injury, the hemodynamic status and the presence of free blood in the peritoneal cavity are predictive factors of mortality (7). Timely intervention and damage control maneuvers can save these patients (7).

Another serious condition for a trauma patient is represented by the pelvic fracture – sacro-iliac screw fixation simplifies treatment (26). Unfortunatelly, although advances have been noticed in trauma critical care, mortality from severe pelvic fractures remains high, with more than a third of deaths secondary to uncontrolled hemorrhage (27). Consequently, an algorithm for treatment severe pelvic fractures has been proposed: damage-control resuscitation, mechanical fixation of the pelvic bones, preperitoneal package, angioembolization and use of Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) (as an alternative to cross-clamping the aorta) (when is feasible) (27). We have to underline that the optimal management of pelvic trauma in the hemodynamically unstable patient is still controversial and its mortality rate can reach up to 50% (11). Usually, mortality occurs early in the acute phase due to exsanguination from uncontrolled haemorrhage or later from sepsis causing multi-organ failure (MOF) due to pelvic infection

from contaminated perineal and rectal wounds (3).

A final idea should be also mentioned: for polytrauma patients, risk of mortality is increased by associated injuries. Association between the head trauma and the retroperitoneal hematoma, along with higher level of lactic acid on admission and high score of ISS, and advanced age are potential risk factors for hospital mortality (28).

Conclusion

Retroperitoneal hematoma is a serious condition for trauma patient (especially for polytrauma, with multiple injuries life-threatening) because of difficulty of diagnosis (CT scan is mandatory) and treatment – non-operative management is indicated for hemodynamically stable patients but emergency surgery, even late, is indicated for abdominal viscera injuries (first of all, the spleen and the liver) and should be recommended by close medical surveillance of the traumatized patient. Algorithm of treatment is adapted to every case but the following sequences are mandatory: rapid transportation to Trauma Centre Level I with medical help, resuscitation, immediate relevant imagistic (CT scan), emergency surgery (even damage-control maneuvers and pelvic fixation) prior to angioembolization or after it, ICU stabilization of the patient and finally definitive repair of the injuries. Mortality remains high.

Conflict of Interest

All authors declare no conflict of interest, financial or non-financial.

Ethical Statement

This study was done by following the ethical rules of a scientific research and the principles of confidentiality, according to World Medical Association Declaration of Helsinki – Ethical Principles for Medical Research Involving Human Subjects (18th WMA General Assembly Helsinki, Finland, June 1964, ammended by the 64th WMA General Assembly, Fortaleza, Brasil, October 2013) and European Data Protection Supervisor Regulations on Data Protection (679/2016 – GDPR), Regulation 45/2001, Regulation 2018/1725 – European Union Committee.

Author's Contributions

Each author contributed equally to conception and design of the study, to acquisition, analysis and interpretation of the recorded data, to draft and revise the article, and final approval of the content for publishing.

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