

ORIGINAL PAPER

doi: 10.5455/medarh.2020.74.115-118

MED ARCH. 2020 APR; 74(2): 115-118

RECEIVED: JAN 18, 2020 | ACCEPTED: MAR 30, 2020

Urgent Surgical Treatment of Blunt Chest Trauma Followed by Cardiac and Pericardial Injuries

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ABSTRACT

Introduction: Widespread opinion that penetrating chest injuries are more urgent, in terms of treatment and care, contributed to underestimation of the urgency of blunt chest trauma, which in most cases is treated conservatively. It remains an open question frequency when the injuries of the heart and pericardium are not timely diagnosed and surgically treated. **Aim:** To demonstrate the importance of well-timed surgical treatment of blunt chest trauma, when coupled with cardiac and pericardial injuries. **Methods:** At the Thoracic Surgery Clinic of the University Clinical Centre Banja Luka, Bosnia and Herzegovina, during period of 10 years (01.01. 2008 – 31.01.2018.), the total of 66 patients were treated for urgent thoracotomy due to clinically and radiologically unclear findings after blunt chest trauma. In general, diagnostic examinations, apart from laboratory analysis, included radiological imaging and Multi Slice Computed Tomography (MSCT) of the chest, followed by an ultrasound of the heart in cases when sternum was injured or when pericardial tamponade was suspected. Results presented in the study were obtained from the retrospective analysis of patients data. This work presents a retrospective observational cross-sectional study, which results in the assessment of the correctness of a particular diagnostic test. **Statistical methods used:** descriptive statistics, counting measures (frequencies and percentages), central tendency measures (arithmetic mean), variability measures (standard deviation). **Results:** Sixty six patients were treated with urgent thoracotomy after a blunt trauma of the chest due to the unclear clinical and radiological finding. In the case of 11 patients (10 men and 1 woman), presenting 16.6% of the total sample, pericardial and cardiac injuries were detected and treated intraoperatively. Further, in the case of the one patient, pericardiotomy and suturing of the right heart chamber were performed, with the creation of a pericardial window. Transthoracic echocardiogram was not used as the primary screening module, but rather as a diagnostic test for patients who had unexplained hypotension and arrhythmia. Radiographs of the chest showed cardiomegaly with or without epicardial fat pad sign suggesting a pericardial effusion. **Conclusion:** Blunt cardiac and pericardial injuries represent a serious therapeutic problem, which, if not treated properly, result in a high mortality rate. Echocardiography is the primary diagnostic method for initial detection of pericardial effusion. Pericardial fluid first accumulates posterior to the heart, when the patient is examined in the supine position. As the effusion increases, it extends laterally and with large effusions the echo-free space expands to surround the entire heart. The size of the effusion may be graded as small (echo free spaces in diastole <10 mm, corresponding to approximately 300 ml), moderate (10-20 mm, corresponding to 500 ml), and large (>20 mm, corresponding to >700 ml). When the ability of the pericardium to stretch is exceeded by rapid or massive accumulation of fluid, any additional fluid causes the pressure with the pericardial sac. Early recognition, pericardiotomy with pericardial window creation and/or ventricular rupture suture remain the "gold standard" in the treatment of blunt cardiac and pericardial injuries.

Key words: Thorax, trauma, heart, treatment.

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1. INTRODUCTION

The widespread perception that penetrating chest injuries are more urgent, in terms of treatment and care, unreasonably contributed to an underestimation of the urgency of blunt chest traumas, which represent injuries with high mortality rate, and are one of the leading death causes

after traffic accidents (1, 2). Although in most cases treated conservatively, it remains an open question of how often blunt chest traumas conditions have not been recognized properly and due to this not timely treated. Knowledge of various types of cardiac injuries, the methods available to facilitate rapid diagnosis, and famil-

ilarity with techniques for surgical repair are no longer an academic exercise but a life-saving necessity (11). In general, the literature supports that patients with any significant blunt trauma to the anterior chest should be screened (13). Tahypnea, irregular lung sounds, chest wall tenderness, chest abrasion, rib or sternal fractures, and seatbelt sign across the chest are some of the physical findings that should raise suspicion for blunt chest injury although they are non-specific (14). Myocardial contusion is an uncommon complication of blunt chest trauma. Chamber rupture is present at autopsy in 36-65% of death from blunt cardiac trauma, whereas in clinical series it is present in 0.3-0.9% of cases and is an uncommon clinical finding (2). Patients with large ruptures or perforations usually die at the scene or in transit—the rupture of a cardiac cavity, coronary artery or intrapericardial portion of a major vein or artery is usually instantly fatal because of acute tamponade. The small, rare, remaining group of patients who survive to hospital presentation usually have tears in a cavity under low pressure and prompt diagnosis and surgery can now lead to a survival rate of 70-80% in experienced trauma centres (2). It is important to take into consideration that any of the radiologic imaging techniques currently available cannot be the only factor when deciding on a possible surgical treatment (1). At the moment it is hard to define the “gold standard” for the diagnosis of blunt heart injuries. Thus, the incidence of cardiac injuries after blunt chest trauma falls within the range of 8% to 76%, and it can be considered as a result of the lack of standardized diagnostic criteria (1,3). As a consequence, no consensus has been established to diagnose blunt cardiac injuries. The situation becomes even more complex, when the injury is a part of polytrauma. Around 64% of the all heart traumas are represented by blunt traumas, being responsible for 20% of deaths caused by motor vehicle collision as part of the traffic accidents. Other mechanisms such as falls, blast injuries, assault, and other blunt mechanisms also play a role (14). Six potential pathophysiology mechanisms have been suggested for blunt cardiac injury: direct, indirect, bidirectional, deceleration, blast, crush, concussive, or combined (12, 14). Direct impact to the chest is considered the most common mechanism, and cardiac injury is most likely when the ventricles are maximally distended at the end of diastole. Indirect cause is due to an increase in preload by way of abdominal or extremity veins that results in a sudden increase in the intracardiac pressure, thereby making the heart susceptible to rupture. Bidirectional forces result in compression of the heart between the spine and sternum. Deceleration mechanisms allow the heart to move freely, resulting in valvular, myocardial coronary artery tears, or laceration (10, 14). Due to their position, the right ventricle and right atrium are more frequently injured (17-32% and 8-65%, respectively) compared to the left ventricle (8-15%) and left atrium (0-31%) (2, 3, 4). In case of pericardium, the blunt ruptures are very rare, though they are considered as serious injuries that can lead to cardiac evisceration and the consequent torsion of large blood vessels. Similarly, the ventricles ruptures are extreme-

ly rare, but most often lethal, followed by hypotension and pericardial tamponade (3, 5). Often unclear clinical picture, coupled with anamnestic data on blunt trauma, hemodynamic instability, and incomplete radiological diagnosis lead the surgeon to explorative thoracotomy, revealing pericardial ruptures, threatening pericardial tamponade, or cardiac ruptures (3). Taking in consideration all aforementioned, it is generally recognized that early recognition and diagnosis, followed with urgent surgical treatment are critical for patient survival (5).

2. AIM

The objective of the present work is to demonstrate the importance of well-timed surgical treatment of blunt chest trauma, when coupled with cardiac and pericardial injuries.

3. METHODS

This work presents a retrospective observational cross-sectional study, which results in the assessment of the correctness of a particular diagnostic test.

At the Thoracic Surgery Clinic of the University Clinical Centre Banja Luka, Bosnia and Herzegovina, during period of 10 years (01.01. 2008 – 31.01.2018.), the total of 66 patients were treated for urgent thoracotomy due to clinically and radiologically unclear findings after blunt chest trauma. In general, diagnostic examinations, apart from laboratory analysis, included radiological imaging and Multi Slice Computed Tomography (MSCT) of the chest, followed by an ultrasound of the heart in cases when sternum was injured or when pericardial tamponade was suspected. Further, after short-term observation, thoracic drainage was performed as an initial therapeutic procedure, followed with Video-Assisted Thoracoscopic Surgery (VATS) exploration and thoracotomy. Results presented in the study were obtained from the retrospective analysis of patients data.

Ethical approval was obtained from Ethical Committee of University Clinical Centre Banja Luka, Bosnia and Herzegovina.

Statistical methods used: descriptive statistics, counting measures (frequencies and percentages), central tendency measures (arithmetic mean), variability measures (standard deviation).

4. RESULTS

In the study period of 10 years, the total of 66 patient were treated at the Thoracic Surgery Clinic of the UKC Banja Luka, for urgent thoracotomy due to clinically and radiologically unclear picture, after blunt chest trauma. For 60 patients (90.9%), osteofixation of the ribs and sternum was performed in order to stabilize the chest wall due to the creation of flail chest (Figure 1). In the case of 11 patients (10 men and one woman), representing 16.6% of the total sample, pericardial and cardiac injuries were surgically treated. In hemodynamically unstable patients, CT – verified flail chest, or CT and transthoracic echocardiogram confirmed cardiac tamponade, it was decided to go for surgical treatment. The average age for this sub-group was 49.6 years.

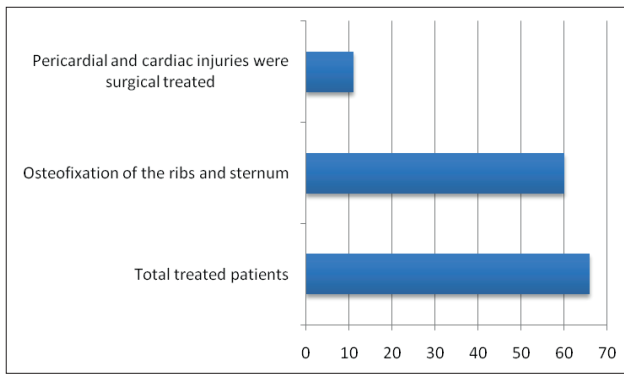


Figure 1. Treated patients during period 2008-2018

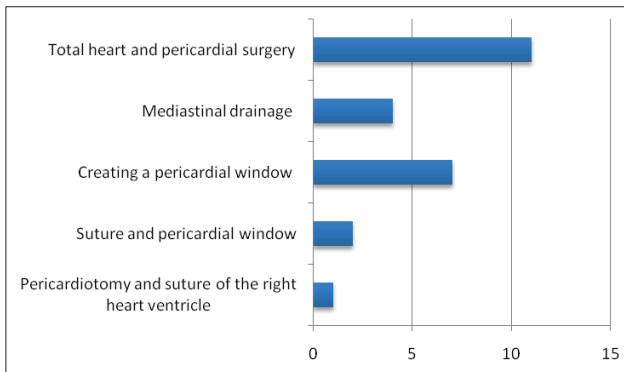


Figure 2. Therapeutic modality

One patient was subjected to pericardiectomy and suture of the right heart ventricle, with the creation of a pericardial window (Figure 2). While for the two patients pericardial rupture was identified intraoperatively and treated with suture and pericardial window. Further, for three patients the clinical and radiological picture indicated threatening pericardial tamponade, due to which a pericardial window creation and evacuation of contents from the pericardium were performed. Transthoracic echocardiogram was not used as the primary screening module, but rather as a diagnostic test for patients who had unexplained hypotension and arrhythmia. Radiographs of the chest showed cardiomegaly with or without epicardial fat pad sign suggesting a pericardial effusion.

Equally, intraoperatively, in case of the four patients hemopericardium was identified, where 200 ml of the content was removed, with creation of pericardial window. Evacuation of a large retrosternal hematoma was performed for one patient, with mediastinal drainage, sternum reposition and osteofixation.

Postoperative death was reported in only one case (1,51%). The patient under the treatment was an elderly man, with an injuries caused by the traffic accident. In addition to chest injury (flail chest and pericardial tamponade), the patient had a pelvic and femur fracture, and spleen rupture, which is confirmed by computerized tomography (CT), femur radiography and echocardiography. His condition was categorized as polytrauma with hemorrhagic shock, where thoracic surgeon performed osteofixation of the ribs and fenestration of the pericardium.

Blunt traumatic cardiac injury presenting with shock is associated with a poor prognosis (2)

5. DISCUSSION

Non-penetrating chest injuries are not necessarily resulting immediate death, but with time their situation often becomes complicated, with high post-hospital mortality rate, of up to 64% (2). In addition to the heart injury, it is often accompanied by several ribs fractures, flail chest, pulmonary parenchyma and spine injuries; contributing all together to the manifestation of a complex symptomatology, with differential diagnostic difficulties (3). At the beginning, after the effect of moderate blunt force on the chest, patient can feel the absence of major difficulties, therefore blunt chest trauma requires longer clinical monitoring (i.e. including electrocardiogram (ECG), an ultrasound, central Venous Pressure (CVP), repeated computed tomography (CT) scan, etc.) (2).

Findings listed above indicate that seven days observation should become a practice even for the patients with apparently minor contusions, to avoid further complications and risks. Also, longer clinical monitoring allows subsequent detection of threatening pericardium tamponade. While, myocardial ruptures are very rare, occurring in a range of about 0.3%–1.1% for blunt chest trauma. The most common procedure used in the treatment of injuries is pericardiectomy with the formation of the pericardial window (3). Ruptures of the ventricles are rarely treated surgically. The handling of the heart ventricles injuries in given conditions requires early diagnosis and treatment, including suture for the cardiac ventricular rupture. Unclear diagnosis in presented condition (i.e. the injuries are overlooked) often results with the death of the patient, due to the blunt chest trauma.

In our study, it was the case of one patient, intraoperatively—due to the exploration of the pericardium. Even with repeated CT, done a few hours after the initial CT scan, it was not possible to make a diagnosis. Rather, the content in the pericardium verified by CT – hemopericardium, together with episodes of hemodynamic instability were the reason for the urgent thoracotomy. Whereas, the clinical signs of threatening tamponade, the CT scan and ultrasonography results were the reason for the urgent thoracotomy and exploration of the pericardium, with the formation of the pericardial window, in case of seven patients.

Echocardiography is the primary diagnostic method for initial detection of pericardial effusion (15). Pericardial fluid first accumulates posterior to the heart, when the patient is examined in the supine position. As the effusion increases, it extends laterally and with large effusions the echo-free space expands to surround the entire heart. The size of the effusion may be graded as small (echo free spaces in diastole <10 mm, corresponding to approximately 300 ml), moderate (10-20 mm, corresponding to 500 ml), and large (>20 mm, corresponding to >700 ml) (16). When the ability of the pericardium to stretch is exceeded by rapid or massive accumulation of fluid, any additional fluid causes the pressure with the pericardial sac.

For three patients, an additional reason for the same procedure was the registered low voltage on the ECG.

Electrocardiograms in cardiac tamponade may show low-amplitude QRS complexes signifying low voltage, and may also depict quasi-specific electrical alternans (caused by “swinging” of the oscillating heart in the buoyant pericardial sac) (17).

Blunt chest trauma can result in a range of cardiac injuries, from asymptomatic arrhythmias to rupture of the ventricles or large blood vessels (2). Pericardial tamponade and ventricular rupture are acute, life-threatening complications of blunt chest trauma, with high mortality rates, despite invasive treatment. Also, among the earlier presented patients, a high mortality rate was registered (1,5%). Consequently, early recognition and diagnosis, followed with urgent treatment are critical factors for the patients survival. Pericardiectomy with the formation of the pericardial window, was the most commonly used procedure among reported patients. In other published studies, similar problems were reported. If the patients examination is not detailed enough, blunt heart injury can be overlooked, and consequences will depend on the injury severity level. According to the literature, cardiac injury is the most commonly overlooked injury, from which trauma patients die. Our findings confirmed that blunt chest trauma can cause a wide array of cardiac injuries, from asymptomatic arrhythmias to rupture of the ventricles or large blood vessels. Among them, pericardial tamponade and ventricular rupture are acute, life-threatening complications of blunt chest trauma, with high mortality rates, despite invasive treatment. Therefore, early recognition and diagnosis, followed with urgent treatment are critical factors for the patients survival. Radiologic techniques cannot be a guide to the choice of therapeutic modality, nor the head of decision-making for surgical treatment, and a multidisciplinary approach, with timely response being imposed as imperative.

6. CONCLUSION

Blunt cardiac and pericardial injuries represent a serious therapeutic problem, which, if not treated properly, result in a high mortality rate. Rib fractures constitute a major part of blunt chest trauma and each additional rib fracture is associated with an increasing likelihood of developing complications. Each additional rib fracture in the elderly population increases the odds of mortality by 19% and of developing pneumonia by 27% (18) The consequences of given injuries will depend on early recognition and diagnosis, and how fast are they followed with surgical intervention. MSCCT of the chest seems to be an irreplaceable diagnostic method, due to the fact that it detects minimal myocardial and pericardial lacerations. Pericardiectomy, with the creation of pericardial window and/or suture ventricles rupture are still representing the “gold standard” in the treatment of blunt cardiac and pericardial injuries.

- **Declaration of patient consent:** The authors certify that they have obtained all appropriate patient consent forms
- **Author's contribution:** D.J. M.S., Z.R., R.K, Lj.K and Z.J.gave a substantial contribution to the conception or design of the work and in

the acquisition, analysis and interpretation of data for the work. M.S., L.J.K. and R.K. had a role in drafting the work and revising it critically for important intellectual content. Each author gave final approval of the version to be published and they agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

- **Financial support and sponsorship:** Nil.
- **Conflicts of interest:** There are no conflicts of interest.

REFERENCES

1. Yousef R, Carr JA. Blunt cardiac trauma: a review of the current knowledge and management. *Ann Thorac Surg.* 2014 Sep;98(3):1134-40.
2. Fitzgerald M, Spencer J, Johnson F, Marasco S, Atkin C, Kossmann T. Definitive management of acute cardiac tamponade secondary to blunt trauma. *Emerg Med Australas.* 2005 Oct-Dec;17(5-6):494-9.
3. Turkalj I, Petrovic K, Stojanovic S, Petrovic Dj, Brakus A, Ristic J. Tupa trauma grudnog koša – pregled povreda dijagnostikovanih MDCT pregledom; *Vojnosanitetski pregled* 2014; 71(2): 161-6.
4. Cindrić Bogdan G. Trauma srca (tamponada srca- perikarda); *Cardiologia Croatica*, 2013; 8 (10 – 11): 331-44.
5. Witt CE, Linnau KF, Maier RV, Rivara FP, Vavilala MS, Bulger EM, Arbabi S. Management of pericardial fluid in blunt trauma: Variability in practice and predictors of operative outcome in patients with computed tomography evidence of pericardial fluid. *J Trauma Acute Care Surg.* 2017 ;82(4):733-741.
6. Sybrandy KC, Cramer MJM, Burgersdijk C. Diagnosing cardiac contusion: old wisdom and new insights. *Heart.* 2003;89:485–489.
7. Alborzi Z, Zangouri V, Paydar S, Ghahramani Z, Shafa M, Ziaeeian B, et al. Diagnosing Myocardial Contusion after Blunt Chest Trauma. *J Tehran Heart Cent.* 2016 ;11(2):49-54.
8. Bansal MK, Maraj S, Chewaproug D, Amanullah A. Myocardial contusion injury: redefining the diagnostic algorithm. *Emerg Med J.* 2005;22:465–469
9. Leite L, Goncalves L, Nuno Viera D. Cardiac injuries caused by trauma Review and case reports *J. Forensic Leg Med.* 2017 Nov; 52 : 30-34
10. Huis In't Veld MA, Craft CA, Hood RE, Blunt C.T. Review *Cardiol.Clin.* 2018; Feb; 36(1) 183:191
11. Richard Embrey, MD Cardiac Trauma, *Thoracic Surgery Clinic;* 2017; 17(1) : 87-93
12. Marcolini EG, Keegan J. Blunt Cardiac injury *Emerg.Med.Clin. NorthAm* 2015; Aug; 33(3) 519:27
13. Clancy, Keith MD, Velopulos, Katherine MD, Bilaniuk, Jaroslaw W MD, Collier, Bryan DO, Crowley, William MD, Kurek, Stanly DO, Lui, Felix MD, Nayduch, Donna RN, et al. Blunt Cardiac Injury Screening for.; *J.Trauma acute care.* Nov.2012. vol 73(5) 301:306
14. Elie MC, Blunt cardiac injuru, *Mt Siraj J. Med.* Mar. 2006. 73 ; 542:52
15. Wann S., Passen E, Echocardiography in pericardial disease *J. Am Soc Echocardiogr.* 2007; 21 : 7-13
16. Pepi M., Muratori M, Echocardiography in the diagnosis and management of pericardial disease, *J. cardiovasc. Med.* 2006; 7:533-14
17. Ariyaratnam V. Spodick DM. Cardiac tamponade revisited : A post-mortem look at a cautionary case. *Tex Heart Inst. J.* 2007; 34: 347:51
18. Yeh DD, Kutcher ME, Knudson MM, Tang JF. Epidural analgesia for blunt thoracic injury—which patients benefit most? *Injury.* 2012;43(10):1667–1671. doi: 10.1016/j.injury.2012.05.022