How to mend a broken heart: a major stab wound of the left ventricle

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Abstract

A 28-year-old male admitted with a stab wound under his left nipple, underwent emergency surgery because of confusion, a decreasing blood pressure and increasing tachycardia. A median sternotomy incision was made and after establishing cardiopulmonary bypass, a 7 cm wound in the left ventricle and a smaller wound in the left atrium were repaired. An injured segment of lung was resected and the left anterior descending and circumflex arteries were grafted after weaning from cardiopulmonary bypass was initially unsuccessful. Although the patient suffered a stroke, probably due to prehospital hypoperfusion, he eventually recovered without major sequelae. In addition to the case report we present a literature review of the last 15 years pertaining the management of penetrating cardiac injury.

Background

One hundred and sixteen years ago Alex Cappelen repaired a penetrating injury of the left ventricle through a left anterior thoracotomy in Christiania (former name of Oslo), in one of the world’s least violent countries [1]. Cappelen’s operation is considered to be the first report of a cardiac surgical procedure. Today trauma centers all over the world perform complex cardiac repairs due to penetrating trauma but the mortality is still high [2-5].

We report the case of a young man who suffered a large stab wound (SW) in the left ventricle and left atrium in addition to a lung injury for approximately 2 h before undergoing reparative surgery. In addition we present a literature review of penetrating cardiac injuries from 1997 – 2012 (Table 1). As data source we used all available English-language articles from peer-reviewed journals in the Ovid MEDLINE and PubMed databases. The articles selected were relevant case reports, original articles and reviews focusing on the clinical presentation of penetrating cardiac injury, initial management, operative technique, complications and follow up.

Case presentation

A 28-year-old male was admitted to the emergency department (ED) with a 5 cm stab wound (SW) under his left nipple. Pre-hospital treatment included insertion of a left chest drain due to dyspnoea, but this was clamped during transport because of massive hemorrhage. On admission, he was self-ventilating, with palpable carotid pulses, but without a measurable blood pressure. He was agitated and pale with a Glasgow coma score of 12 since he could open his eyes, localize pain and speak. The blood pressure ranged from 80/60 to 100/60 mmHg after starting intravenous fluid therapy and he had a tachycardia of 100–120 beats per minute. When the clamp was removed from the chest drain, 650 ml of blood was rapidly drained. The chest x-ray showed persisting hemothorax and atelectasis and an additional drain was inserted. The arterial saturation varied from 86% to 98% and blood gas analysis showed a haemoglobin of 12.6 g/l, pH 7.17, base excess –9 and lactate 5.5 mmol/l. Focused Assessment with Sonography in Trauma (FAST) revealed no blood in the pericardium and upper abdomen. The neck veins were not distended and so the patient received transfusion of 1500 ml of crystalloid fluid and 250 ml of red cells. The blood pressure decreased as soon as the intravenous therapy was reduced, the tachycardia did not resolve and the patient was therefore transferred to the operating room.

After intubation, the ECG showed ST elevation and a median sternotomy incision was rapidly performed. The
| Ref nr, author, year, journal and study origin. Study type | Patients/patient group/injury site | Outcomes/performed surgery | Key results | Comments |
|-----------------------------------------------------------|-----------------------------------|-----------------------------|-------------|----------|
| [2] Asensio et al. (1998), J Trauma, USA. Prospective evaluation | 2-year prospective evaluation of 105 penetrating cardiac injuries | 65% GSW (survival 16%), 35% SW (survival 65%). EDT in 76 pts with 10 survivors (16%) | Presence of cardiac tamponade and the anatomical site did not predict outcome, presence of sinus rhythm when the pericardium was opened did | |
| [6] Baker et al. (1998), Arch Surg, USA. Retrospective study + review | 106 pts with penetrating heart injury (1989–1995): 60 GSW, 46 SW, 55% overall survival. 6 patients on CPB (4 gunshots, 2 stabs, only 2 GSW survived) | Few survivors due to long time from injury to CPB. Those who were resuscitated >5 min prehospital carried a very poor outcome. SR at admission—a good prognostic sign. CPB no good to reverse outbled situation/profound shock, but necessary to repair multichamber injuries/large injuries | | |
| [7] Bar et al. (2009), Ind J Thorac Cardiovasc Surg, Israel. Retrospective study | 14 pts with penetrating cardiac wound requiring operation (1999–2006) (9 SW, 2 GSW and 2 shrapnel injuries, 1 multiple trauma) | 4 sternotomies, 10 anterolateral thoracotomies (8 with sternum transection). SLV, 6RV, 3RA injuries – all single chamber injuries, no combined. | No CPB, 100% survival, all discharged | Mean interval from injury to surgery 37 min |
| [8] Barbosa et al. (2011), Interact Cardiovasc Thorac Surg, Argentina. Case report | 18 yr male, SW in 4th ic space in the left midclavicular line | Left thoracotomy, suture of right ventricular wound at admittance | Developed pneumonia/lung edema postop, after 30 days AVR for penetrated aortic valve and closure of shunt (RV -> aorta) | |
| [9] Bowley et al. (2002), Ann Thorac Surg, South Africa. Case report | 24 yr male, multiple stab wounds | No vital signs, PEA, at EDT: tamponade. 2 cm LV wound with LAD transsection, transected PDA on the opposite side (RV) | Initially Foley catheter in the wound, mattress sutures, LAD ligation, PDA ligation, VF, hypotension, OPCAB with right gastroepiploic artery. Died of respiratory complications due to Brown-Sèquard lesion (another stab injury to the spinal cord) | |
| [10] Burack et al. (2007), Ann Thorac Surg, USA. Retrospective study | 207 pts with mediastinal penetrating trauma 1997–2003, 72 (35%) unstable. | 72 unstaibel pts, 15% had cardiac injury with 18% survival when explored in ED and 71% when reached OR | With penetrating mediastinal trauma the mortality is 85% when moribund at arrival and 55% when unstable (overall data, not injury specific) | |
Table 1 Overview of the papers on penetrating cardiac injury from 1997 to 2012 (Continued)

| Reference | Year, Journal, Location | Study Design | Number of Patients | Details of Injury | Outcome |
|-----------|-------------------------|--------------|--------------------|------------------|---------|
| [11] Carr et al. (2011), J Trauma, USA. | Retrospective study | 2000-2009 | 28 SW with 17 survivors (61%), no information about anatomical site | Functional outcome (5yrs) after: if coronary arteries were not involved - good chance to normal cardiac function at follow up. |
| [12] Chughtai et al. (2002), Can J Surg, Canada. | Review + case report | Cases of 9 pts, 8 managed with CPB in trauma setting from 1992-1998 | Only 2 pts of the presented had a sole cardiac injury (LV + coronary artery, RA + intrapericardial vena cava) | The patient with LV and coronary artery injury died (no CPB), the other patient survived without sequelae |
| [3] Clarke et al. (2011), J Thorac Cardiovasc Surg, South Africa. | Retrospective study | All patients with penetrating cardiac injury requiring operation from 2006-2009 | Of 1062 stab wounds, 104 were operated, 76 had cardiac injury, overall mortality 10%. Approx 50% median sternotomy, 50% left thoracotomy | When data put together with mortuary data: mortality of 30% for SW (in the mortuary cohort of 548 patients with SW, 38% had penetrating cardiac injury). Less than 25% with penetrating cardiac injury reach hospital alive, of these ca 90% survive. |
| [13] Claassen et al. (2007), J Trauma, USA. | Case report | 2 male pts : 21 yr and 27 yr | Pas 1: SW in 5th right ic space (axilla) (+ in abdomen), 400ml on chest tube + knife blade in thorax: laceration of right ventricular outflow tract (sutured) + lung resection | Pas 2: SW in left supraclav midline. Tamponade at FAST: pericardial drainage, thereafter stable. Sternotomy after transfer, laceration of the pulmonary outflow tract, sutured, further repair of aortopulmonary shunt (thrill + TEE) |
| [14] Comoglio et al. (2010), Int J Emerg Med, Italy. | Case report | 75 yr male with chest pain and syncope, had been working with a nailgun | Stable, underwent CT where the nailgun nail was found imbedded in the left ventricular wall. Removed through median sternotomy, suture without CPB | The pt underwent formal coronary angiography to rule out underlying coronary disease |
| [15] Desai et al. (2008), J Thorac Cardiovasc Surg, Canada. | Brief communication | 22 yr male, single SW in the left chest | Severe shock, loss of vital signs in the ED. EDT, ROSC after opening of pericardium. Tamponade + through-and-through laceration of the RV, stapled and transferred to OR | CPB, staples had occluded the PDA, the wound in close proximity. Staples removed, wound sutured. Intraoperative fluorescence coronary angiography showed widely patent PDA |
| [16] Fedalen et al. (2001), J Trauma, USA. | Case report | 30 yr male, isolated SW to left anterior chest wall | Tension pneumothorax, hypotension, cardiac tamponade. Transfer to OR | Median sternotomy, proximal laceration of LAD with posterior wall of the vessel intact. OPCAB with SVG, intraluminal shunt. Laceration used as |
### Table 1 Overview of the papers on penetrating cardiac injury from 1997 to 2012 (Continued)

| Reference | Year | Source | Case Report | Clinical Details | Procedure and Outcome |
|-----------|------|--------|-------------|------------------|----------------------|
| [17] Fulton et al. (1997), Ann Thorac Surg, South Africa. Case report | 1997 | Case report | 61 yr male, a single SW in right 2nd ic space parasternally. History of right-sided empyema 18 yrs ago treated by thoracotomy and decortication | Stable, enlarged mediastinum at chest X-ray. Angiography showed laceration to innominate artery, left common carotid artery and left subclavian artery. Distal cannulation, repair in deep hypothermic arrest | Uneventful postoperatively, discharge at day 10 |
| [18] Hibino et al. (2003), Journal of Cardiac Surgery, Japan. Case report | 2003 | Case report | 39 yr male, SW anterior chest wall, suicide attempt. | Median sternotomy at OR. Injury of the right ventricular outflow tract, repair without CPB | 2 yr after aorto-right ventricular fistula (dyspnea), repair with patch and AVR. The authors suggest long term follow-up to detect unidentified lesions |
| [19] Ito et al. (2009), Gen Thorac Cardiovasc Surg, Japan. Case report | 2009 | Case report | 51 yr male, SW in left 5th ic space with the ice pick still in place, suicidal attempt | Ice pick was moving synchronously with heart beat, echo showed tip in right ventricle, cardiac tamponade | CPB, mattress stich. Heart murmur day 12, 5mm ventricular septal defect detected. No surgery, follow up |
| [20] Jodati et al. (2011), Interact Cardiovasc Thorac Surg, Iran. Case report | 2011 | Case report | 24 yr construction worker, shortness of breath and palpitations, unaware of the pneumatic nailgun injury | Nail through RV outflow tract, interventricular septum, through the mitral valve at TEE and CT. | Median sternotomy, CPB. Entry point on RV, nail tip barely visible, not exit wound after LA was opened. Nail removed, anterior leaflet of mitral valve repaired. Discharge at postop day 5 |
| [21] Kang et al. (2009), Injury, New Zealand/Canada. Review | 2009 | Review | | | Few other conditions in medicine are as lethal; death occurs from cardiac tamponade or exsanguination; the greatest danger is missing the dgn; resuscitation is of limited value; immediate operative intervention is the only meaningful treatment |
| [22] Karin et al. (2001), Eur J Emerg Med, Israel. Case report and literature review | 2001 | Case report and literature review | 1. 29 yr male with single SW in left chest. 2. 35 yr male, stabbed in left lower thorax | 1. Cardiac tamponade, ED thoracotomy. SW in the LV transecting LAD (ligated, sutured). CPB with SVG in OR 2. Hemopneumothorax, respiratory distress, chest tubes. FAST: tamponade. Left thoracotomy at OR, distal LAD transection, ligated. | Both had normal echocardiographies postoperatively and were discharged respectively 10th and 7th postop day |
Table 1: Overview of the papers on penetrating cardiac injury from 1997 to 2012 (Continued)

| Reference | Study Design | Patient Details | Intervention | Outcome |
|-----------|--------------|-----------------|--------------|---------|
| [23] Kurimoto et al. (2007), Surgery today, Japan. Case report | 57 yr male, SW in 5th ic space parasternally, suicide attempt | Arrest prehospitaly, EDT at admission + pericardiotomy, further percutaneous CPB + repair at ED. 3 cm left ventricular wound near coronary artery | Postop encephalopathy, 3 yrs afterwards at rehabilitation home |
| [24] Lau et al. (2008), Singapore Med J. Case report | 31 yr male, 2 SW in the left 4th ic space and in the right 2nd ic space | Pulseless with PEA, EDT, SW in the RV, internal cardiac massage to ROSC, transfer to the OR. Suture of the laceration | Discharged to further rehabilitation due to hypoxic encephalopathy |
| [4] Molina et al. (2008), Interact Cardiovasc Thorac Surg, USA. Retrospective study | 237 pts (2000–2006) with EDT for penetrating injury, of these 94 with penetrating cardiac injury | GSW 87%, SW 13%, overall survival 8% (5% for GSW, 33% for SW) | None of the patients who reached OR needed CPB. Predictors of survival: sinus rhythm, signs of life at ED, SW vs GSW, transport by police, higher GCS |
| [25] Moore et al. (2007), Am Surg, USA. Case report | 16 yr male, multiple stab wounds | Tachycardia and hypotension, left hemothorax. FAST: pericardial and infraabdominal fluid. LAD injury (ligation), RV (suture). | OPCAB (SVG) due to evolving large anteroseptal MI. Abdominal packing. Discharge postop day 17. |
| [26] Nwiloh et al. (2010), Ann Thorac Surg, USA/Nigeria. Case report | 11 yr boy, arrow in the 4th ic space | Pt admitted 3 days after hunting with arrow in the midline. Attempted retracted at local hospital, referred to the visiting cardiothoracic team from USA. TTE: arrow through right ventricle, ventricular septal shunt | CPB, retraction of the arrow and suture of the RV. Shunt was insignificant, not repaired |
| [27] O’Connor et al. (2009), J R Army Med Corps, USA. Review | History, demographics and outcome, repair techniques, special occasions etc. | | Refer to iv adenosin infusion for temporary arrest to facilitate the repair |
| [28] Parra et al. (2010), J Thorac Cardiovasc Surg, USA. Case report | 81 yr male struck by a stingray in his left chest | CT: left pneumothorax, foreign body through mediastinum. Left anterior thoracotomy at the OR, the barb was found imbedded in the heart, the entry was repaired and pt transferred to a cardiac center | At cardiac center: CPB, barb through both right and left ventricles. RA was accessed and the barb pulled out in an antegrade fashion. Ventricular septal and RV defects closed with pledged sutures. Discharge 60 days postop. Splenectomy due to hemorrhage postop day 1 (unidentified injury, the pt fell when attacked by the sting ray) |
| [29] Seamon et al. (2009), J Trauma, USA. Retrospective study | 283 pts with cardiac or great vessel penetrating injury | 88% GSW (survival 2.8%), 12% SW (survival 24.2%) | Predictors of survival in multivariate | Multiple GSW almost unsalvageable |
Table 1 Overview of the papers on penetrating cardiac injury from 1997 to 2012 (Continued)

| Reference | Source | Year(s) | Case/Study Type | Patient Details | Intervention | Complications/Outcomes |
|-----------|--------|---------|----------------|----------------|--------------|------------------------|
| [30] Sugiyama et al. (2011), Ann Thorac Surg, USA. | Case report | 2000–2007 | 20 yr male, SW in left chest (nipple level) | Cardiac arrest at ED, left anterior thoracotomy, suture of right ventricle | Postop instable, 7-day - 1.9 cm septal defect with left to right shunt (3.7-1), ARDS etc., shunt=VSD repaired 2 months afterwards |
| [5] Tang et al. (2011), Arch Surg, USA. | Retrospective study | 2000-2010 | 406 pts with penetrating cardiac injury from 2000-2010 | 74% SW, 26% GSW. Overall survival 27% | Focusses on postdischarge complications, 17% had an abnormal echocardiogram at follow-up; all managed conservatively |
| [31] Tasdemir et al. (2011), Acta Cardiol, Turkey. | Case report | 19 yr male, SW left chest | Presented in shock, tamponade and complete bilateral visual loss. SW of LV with LAD injury, | CPB, SV graft to LAD, vision gradually regained |
| [32] Toda et al. (2007), Interact Cardiovasc Thor Surg, Japan. | Case report | 50 yr male, 3 SW by 30 cm sashimi knife, (Neck, 4th ic space, right upper quadrant of abdomen), suicidal attempt | Hypotensive, FAST negative, CT showed pneumopericardium and left hemothorax | Median sternotomy, RV laceration, repair by pledgeted sutures. LV laceration near posterolateral branch of CX, without bleeding, covered with TachoComb. |
| [33] Topal et al. (2010), J Trauma, Turkey. | Retrospective study | Penetrating cardiac injury (57 SW, 4 GSW), 2002-2009 | 53 left thoracotomies, 4 median sternotomies. 2 LAD injuries, ligated. Total mortality 15% (isolated RV −11%, isolated LV 31% (mixed SW and GSW). | 95% injury in 1 chamber. Focusses on predictors of outcome: > mortality when uncounscious, BP<50, low Hct, Na, temp and PH. Patients pronounced “dead on arrival” were not assessed in this study. |
| [34] Topaloglu et al. (2006), Tex Heart Inst J, Turkey. | Case report | 19 yr male, SW with skewdriver in 5th left ic space | Dyspnea and hypotension, 1500ml chest tube output. Left anterior thoracotomy at OR, RV wound repair. | 1 week later a cardiac murmur occurred, transfer to a cardiac center, TTE perforation of membranous septum and anterior leaflet of the mitral valve. Median sternotomy, CPB, LA access, pericardial patch repair of the leaflet, suture of the septal defect through RA. Discharged postop day 5. |
| [35] Topcuoglu et al. (2009), Thorac Cardiovasc Surg, Turkey. | Case report | 14 yr male, SW in right 6th icr paravertebrally, stable with knife in place | Right posterolateral thoracotomy (knife in situ), at removal bleeding from atrio-inferiocaval junction | Repair on CPB, discharged on 7th postop day |
pericardium was opened and although there was a clot ventral to the heart, there were no signs of cardiac tamponade. There was a 6 cm cut in the lateral pericardium corresponding to the stab wound in the chest and a 7 cm, almost transmural wound in the left ventricle, parallel to a major diagonal branch (Figure 1). The wound was not bleeding. A 5 cm stab wound in the left lung (Figure 2) was sutured and cardiopulmonary bypass (CPB) was established. The cardiac injury ended close to the origin of the left main stem and crossed the left atrium. The ventricular wound was repaired with single mattress sutures reinforced by strips of bovine pericardium (Figures 3, 4) without arresting the heart and without cross-clamping the aorta. The left atrium was sutured using 5/0 Prolene (Ethicon). Blood appeared in the tracheal tube and bronchoscopy revealed ongoing bleeding from the left lung which required resection of the lingula. Weaning from CPB was initially unsuccessful and we suspected that there had been injury to the left main stem either caused by the initial stab or by the hemostatic sutures. The left anterior descending artery was grafted using the internal mammary artery and a vein graft was anastomosed to the circumflex artery. The patient was thereafter successfully weaned from CPB.

Post-operatively, the patient had signs of a stroke and a CT scan revealed a cerebral infarction. One week after surgery he was transferred to the neurological intensive care unit. After three weeks he was awake and self-ventilating. He was moved to his local hospital and was discharged after 6 weeks with only a minor deficit affecting the left upper extremity.

**Discussion**

We report the case of a young male patient with a major cardiac stab wound combined with lung injury. Our patient was stabbed during a violent quarrel, thus being a typical stab victim, however, in Japan suicide attempts seem to be equally frequent [18,23]. In large series, gunshot wounds (GSW) are the predominant cause of cardiac penetrating trauma [2,4,6,29]. In Norway, this type of injury is obviously less common but still existing [37-39].

| [36] Gwely et al. (2010), Thorac Cardiovasc Surg, Egypt. Retrospective study | 73 pts operated for cardiac SW (1998–2008) | Unstable 35%, 20% cardiac arrest prior to EDT. Mortality 23% | Poor prognosis: cardiopulmonary resuscitation (mortality rate 68%), EDT (67%) and shock (50%) on admission | Dead on arrival excluded |

AVR - aortic valve replacement, CABG - coronary artery bypass, CPB - cardiopulmonary bypass, CX - circumflex artery, ED - emergency department, EDT - emergency department thoracotomy, FAST - focused assessment with sonography in trauma, GCS - Glasgow coma scale, GSW - gunshot wound, LA - left atrium, LAD - left anterior descendent artery, LV - left ventricle, OPCAB - off pump coronary artery bypass, OR - operating room, PDA - posterior descendent artery, RA - right atrium, ROSC - return of spontaneous circulation, RV - right ventricle, SVG - saphenous vein graft, TEE - transesophageal echocardiography, VF - ventricular fibrillation.
Knife is the most common weapon for stab injuries, followed by other sharp items such as screwdrivers [34], ice picks [19], chopsticks, pneumatic nailgun nails [14,20,40] but also curiosities as barb from a sting ray [28]. Fractured ribs or sternum are also reported to cause cardiac penetration [41]. Pneumatic nails might be shot without the patient noticing and cause surprise when detected by CT scan or eccocardiography imbedded in the heart [14,20]. The iatrogenic penetrations of the heart due to different medical devices (pacemaker leads, intracoronary stents, Amplatzer devices) are not discussed in this paper.

Penetrating cardiac wounds are mostly fatal either due to cardiac tamponade, exsanguination or coronary artery injury [1]. Clarke reports that of 1064 patients with stab wounds to the chest 104 were operated and 76 were found to have a cardiac injury [3]. The overall mortality was 10% giving an impression of low mortality in this particular group of cardiac injuries. However, when the data was put together with the mortuary report for the same time, the mortality for penetrating cardiac stab wounds was found to be 30%. Most of the studies are retrospective and the patient selection is determined by the survivors arriving at the hospital and ignorance of the mortuary data. Topal et al. report a mortality rate of 15% in 61 penetrating cardiac cases with predominantly stab wounds but state that “patients pronounced dead on arrival were not assessed in this study” [33]. The only known prospective study reports another reality with a mortality rate of 97% when multichamber penetrating injury is present [2]. Also Molina et al. reports high mortality (67%) in a cohort with mainly stab wounds throughout the last decennium [4].

Our patient maintained suboptimal circulation for approximately two hours before undergoing surgery. The time span taken into consideration, our patient was extremely lucky as the outcome is usually poor when the time from trauma to surgery increases [5,6]. An Israeli study of 14 patients reports 100% survival (9 SW, 2 GSW, 1 shrapnel injury and 1 multi trauma) with the mean time from injury to surgery of 37 min [7]. In addition to fast admission to surgery, this outstanding result may also be due to the fact that all patients had single chamber injuries and no coronary artery injury. According to Burack et al., patients with penetrating mediastinal trauma triage themselves between operative intervention or evaluation and observation as they present either stable or unstable on admission. In this retrospective study the authors present 207 patients of which 72 were unstable [10]. Of these 15% had cardiac injury with 18% survival when explored in the ED. The survival rate was 71% when patients with penetrating cardiac injury reached the operating room. All patients having cardiac injury in this study were unstable (authors criteria: traumatic cardiac arrest or near arrest and an emergency department thoracotomy (EDT); cardiac tamponade; ATLS grad III shock despite fluid resuscitation; chest tube output >1500 ml at insertion; chest tube output >500 ml in the initial hour; massive hemothorax after chest tube input). The study does not report the use of CPB.

In our patient, there was a large stab wound of the left ventricle running parallel to the diagonal artery as well as a stab wound in the left atrium. Regarding the location of penetrating cardiac injury, the right ventricle is the most common due to its ventral anatomical position,
followed by the left ventricle, right atrium and left atrium [2,3,11]. The patients with a single right ventricle injury are mostly salvageable whereas those with multichamber injuries have a very high mortality [2,4,21]. The concomitant injury of the lung in our patient is not a rarity [3]. Our patient did not suffer from cardiac tamponade as there was a large opening to the left pleural cavity through the wound in the pericardium. This probably saved his life, although profound hypovolemia can conceal signs of cardiac tamponade leading to delayed diagnosis [36]. However, cardiac tamponade in the reviewed studies is not a prognostic factor regarding survival [2,33].

The role of CPB has been debated in trauma surgery, especially when it comes to penetrating cardiac wounds [6,21]. Some series present large cohorts of penetrating cardiac injury without use of CPB [3-5]. In case of complex cardiac injuries with multichamber lacerations the advantages of a bloodless and still operating field is obvious [6,20,21]. The required heparinisation for CPB might be deleterious in a trauma patient. However, if the bleeding source or sources can be controlled, the risk of further profound haemorrhage is low. On the other hand, full heparisation might cause severe morbidity, and CPB might initiate consumptive coagulopathy and profound systemic inflammatory reaction [28]. Off pump cardiopulmonary bypass is an alternative when it comes to coronary artery lesions [16,22,25]. Establishing CPB in arrested patients or patients in deep haemorrhagic shock is not favourable for the outcome [6]. It could be debated whether or not the aorta should have been cross-clamped in our patient during repair of the left ventricular wall and coronary bypass surgery, but the ECG changes and the suspicion of pre-existing ischemia due to sustained pre-operative hypoperfusion, persuaded us to leave the aorta unclamped in this particular case.

Peroperative fluorescent angiography is a reliable tool to identify suspect coronary artery involvement peroperatively either caused by the injury itself or the surgical procedure [15], unfortunately this technique was not available at our OR. Cardiac stabbings might lead to initially unidentified additional injuries which become apparent first several weeks to years later [8,18]. One study with a large series of patients report that these injuries seldom need surgical treatment [5]. There is consensus that echocardiographic assessment should be provided during the hospital stay [5,11].

On admission to the ED, our patient was given a high Glasgow coma score (GCS), yet post-operatively was found to have had a cerebral injury. Unfortunately, the patient was foreign, and despite speaking, nobody could assess his verbal response adequately. Furthermore, he received an intravenous injection of Ketalar a few minutes after admission, following which he needed assisted manual ventilation and was no longer able to communicate. The initial GCS was later reconsidered and probably the patient suffered from major hypoxia in the pre-hospital phase. Nevertheless the patients with lower GCS have poor outcome, Asensio still reports a high mortality rate (27%) for patients with Glasgow Coma Scale >8 [2]. However, in an emergency room thoracotomy material GCS was found to be a predictor of survival, despite none of the patients had a score >7 [29]. In our patient, it is possible that CPB might have caused cerebral injury by embolization or by giving an insufficient cerebral perfusion pressure. With pre-existing cerebral damage, the standard perfusion pressure during CPB in our patient (mean arterial pressure 50–60mmHg) might not have been high enough to meet the needs of the brain already damaged by hypoperfusion.

Patients with a simple penetrating cardiac injury might be successfully managed without a cardiac surgeon present [2,3]. However, repair of a severe wound of the left ventricle and the complications that can arise will require the surgical skills of a cardiac surgeon, as demonstrated in the present study and the likelihood of survival will be considerably increased by the immediate availability of a cardiac surgical service. The cases where initial tamponade was managed at a lower trauma care center with further transfer for definite surgery, witness of general surgeon’s competence of the initial management of these patients [13,28]. In our level I trauma center, a cardiothoracic surgeon in the trauma team has been practiced for decades and we believe provides optimal management of patients with penetrating cardiac trauma.

Conclusions
We present a complicated case of a young male patient with a chest stab wound who served the trauma team both diagnostic and treatment challenges. We provide the reader a review of literature of the last 15 years publications on penetrating cardiac injury, focusing on stab wounds. Our patient suffered a stroke which origin could be multigenetic, prehospital hypoperfusion, air emboli due to major lung injury and/or insufficient perfusion pressure or microemboli during the cardiopulmonary bypass. The patient in our study survived with minor sequelae due to coordinated work of the trauma team in charge. In conclusion, if the patient with a penetrating stab wound in the heart is not obviously dead on arrival, an attempt for cardiac repair should be done with or without CPB.

Competing interests
The authors declare that they have no competing interests.

Authors’ contribution
Both authors were operating surgeons regarding the presented patient case. TT provided the idea of the article. M-L K drafted the initial manuscript while
both authors worked on improvement and refining of the final manuscript. Both authors read and approved the final manuscript.

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