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Penetrating cardiac trauma: Surgical treatment in 2 Emergency Hospitals in Mexico City

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Abstract

Introduction: In Mexico, despite having experience in cardiac trauma (TRACAR), there are few reports. We present the surgical experience of two Trauma Hospitals in Mexico City.

Methods: A retrospective analysis of patients with TRACAR treated in Hospital "Balbuena" and "La Villa" was performed between the period from 01 January 2012 to 31 December 2017.

Results: 23 patients were included in this study. 13 (56.5%) survivors and 10 (43.5%) non survivors. The ratio male/female was 12/1 vs 9/1, regarding the type of lesion (firearm projectiles, [FP] vs penetrating object, [PO]) and survival, [FP 7 (53.85%) vs PO 6 (46.15%)] vs [FP 8 (80%) vs PO 2 (20%)]. The frequency of wounds was the following: pericardium 9 (28.11%) vs 6 (18.75%), right ventricle 5 (15.63%) vs 6 (18.75%), left ventricle 1 (13.13%) vs 2 (6.25%), right atrium 2 (6.25%) vs 1 (3.13%). Regarding the AAST classification of the frequency was; grade I:6 (46.15%) vs 2(20%), grade II: 4 (30.76%) vs 0, grade III: 3 (23.09%) vs 4 (40%). The utilized surgical approach was left anterolateral : 14 (8[61.54%] vs. 6[60%]); bilateral: 4 (2[15.39%] vs. 2[20%]); sternotomy 3 (1[7.69%] vs. 2[20%]); combined 1 (1 [7.69%] vs. 0); and right 1: (1(7.69%) vs 0).

Conclusion: Cardiac trauma is an entity with a high mortality which requires urgent treatment; it currently occurs in younger populations predominantly by firearm projectiles. Our results are consistent with those reported on other series.

Introduction

Cardiac trauma is considered a challenge for surgical teams, due to its high mortality rate. According to the national data base of the American College of Surgeons (ACS) an incidence of 0.16% of penetrating cardiac trauma in their trauma centers. In addition, it is accepted that 6.4% of the penetrating chest injuries involve the heart.

Currently 60-80% of the patients die at the site of the injury or during hospital transfer, the reported survival rate is 3-84% according to the frequency observed in each center.

In our environment, despite having experience in the treatment of these type of injuries there is little information in literature, which is the result of the surgical teams in each hospital and has been communicated in descriptive or clinical cases.

In this paper we present the surgical experience with penetrating cardiac trauma in two hospitals of health sector of Mexico City during the years 2012 to 2017.

Methods

The study was conducted in the General Hospital of "Balbuena" and the General Hospital of "La Villa", both of which are part of the hospital network of the health services of Mexico City. They provide medical attention to the open public and have 185 and 150 beds, respectively. Due to the qualities of our organization and patient care in any circumstance they are considered emergency care hospitals and trauma centers and correspond to a level 2 center according to the American Trauma Society.

Through a case series design, patients where analyzed in a retrospective and retrolective form, consecutive patients with the diagnose of cardiac trauma which where surgically treated in the previously mentioned hospitals in a period between January 1, 2012 and December 31, 2017.

The registration of demographic data and surgical outcome were obtained through present patient archives in both hospitals. Those patients who arrived at the emergency department with fatal cardiac trauma and didn´t receive surgical treatment, were excluded. The recollected data included type of wound, surgical requirement, blood products and outcome in the intensive care unit.

The classification of the type of wound was performed by the American Association of the Surgery of Trauma (Cardiac Injury Scale) which classifies the injuries in 6 differential grades:

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Grade I: pericardia injury without cardiac affection, cardiac tamponade or cardiac herniation.

Grade II: tangential myocardia injury without endocardia extension or cardiac tamponade.

Grade III: cardiac injury with interventricular septum rupture, pulmonary or tricuspid valvular insufficiency, papillary muscle disfunction or coronary arterial occlusion without cardiac failure evidence. A closed wound with pericardia tear and cardiac herniation. Cardiac closed injury with cardiac failure. Open tangential myocardia injury with cardiac failure without endocardia affection, but with cardiac tamponade.

Grade IV: cardiac injury with interventricular septum rupture, pulmonary or tricuspid valvular insufficiency, papillary muscle disfunction or coronary arterial occlusion with signs of cardiac failure. Cardiac injury with mitral or aortic valve insufficiency. Cardiac lesion with right ventricle compromise or one of the two atria.

Grade V: Cardiac injury with proximal coronary artery occlusion. Cardiac injury with left ventricular perforation. Injury by cardiac outbreak with less than 50% loss of right ventricle, right atrium or left atrium.

Grade VI: closed injury with cardiac avulsion or penetrating wound with a chamber loss greater than 50%. Advance 1 grade in the presence of penetrating multiple wounds in one or more cavities.

Treatment intervention was performed according to the Advanced Trauma Life Support (ATLS) guidelines from the American College of Surgeons, which were implemented in these hospitals previously.

Statistical analysis

The nominal variables are presented as frequencies and percentages, the numeric variables with median (percentiles 25, 75). The differences between variables was calculated with the U Mann-Whitney test. The bivariable correlations were analyzed with Spearman´s rho. A $p<0.05$ was considered significative.

Results

23 patients were accepted with cardiac trauma diagnosis during the period previously mentioned for the analyses (Tables 1 and 2). The variables gender, age, surgical time and days in the intensive care unit in whom survived and who did not, are shown in the graphics respectively.

In the group that survived 13 (56.5%), vs the non-surviving group 10 (43.5%), the relation masculine/feminine gender was 12/1 vs 9/1 respectively; in correspondence to the type of injury (fire arm wound vs penetrating object and survival or death, FP 7 (53.85%) vs PO 6 (46.15%) vs FP 8 (89%) vs PO 2 (20%)

In the exposed graphics 3 and 4, according to their condition of survival, the related variables related to the grade of injury of the AAST, the surgical thoracic approach, the cardiac injury and the associated injuries in each subject.

Heart injuries were mainly combined with more than one affected structure, but also combined with injuries to other organs (Tables 3 and 4). Only in 3 patients a single injury to the right ventricle was documented, without other associated organic injuries.

The total frequency of cardiac injuries in surviving patients, vs non-surviving patients respectively were: affected pericardium 9 (28.11%) vs 6 (18.75%), right ventricle 5 (15.63%) vs 6 (18.75%), left ventricle 1 (13.13%) vs 2 (6.25%), right atrium 2 (6.25%) vs 1 (3.13%).

Table 1. Heart trauma survivor patient relation

No.	Gender	Age	Injury	Time until surgical management (min)	Intensive care Unit stay (days)
1	M	20	FP	30	2
2	F	30	FP	40	5
3	M	18	FP	60	2
4	M	17	FP	45	7
5	M	33	FP	20	1
6	M	48	FP	20	4
7	M	27	FP	50	7
8	M	18	PO	40	10
9	M	16	PO	30	1
10	M	20	PO	30	5
11	M	45	PO	45	14
12	M	33	PO	30	10
13	M	26	PO	45	5

M: Male; F: Female; FP: Firearm projectile; PO: Penetrating object

Table 2. Non-surviving heart trauma patient relation

No.	Gender	Age	Injury	Time until surgical management (min)	Intensive care Unit stay (days)
1	M	21	FP	30	0
2	M	20	FP	60	0
3	M	41	FP	40	0
4	M	21	FP	40	0
5	M	30	FP	20	1
6	M	38	FP	40	0
7	M	22	FP	40	2
8	M	32	FP	30	2
9	F	38	PO	20	0
10	M	22	PO	30	0

M: Male; F: Female; FP: Firearm projectile; PO: Penetrating object

Table 3. Classification according to injury type in surviving heart trauma patients

No.	AAST Classification	Surgical Thoracic aproach	Cardiac Injury	Associated Injuries
1	**I**	Sternotomy	Pericardium	Lung
2	**III**	Right	Right ventricle and right atrium	None
3	**I**	Sternotomy + Left	Pericardium	Pulmonary artery, stomach
4	**I**	Left	Pericardium	Liver, Diafragm
5	**I**	Left	Pericardium	Lung
6	**I**	Bilateral	Pericardium	Lung
7	**II**	Left	Pericardium, left ventricle	None
8	**II**	Left	Right ventricle, pericardium	None
9	**I**	Left	Pericardium, internal mamary artery	Lung
10	**III**	Left	Pericardium, right ventricle	None
11	**III**	Left	Right ventricle	Small bowel
12	**II**	Left	Right ventricle	Spleen, small bowel, colon
13	**II**	Bilateral	Right atrium	Lung, liver, stomach, small bowel

AAST: American Association of Surgical Trauma

According to the AAST the frequency of grades of compromise in subjects with heart trauma who survived and did not, respectively were: grade I: 6 (46.15%) vs 2 (20%), grade II 4 (30.76%) vs 0, grade III 3 (23.09%) vs 4 (40%) and grade IV 0 vs 4 (40%).

Table 4. Classification according to the type of injury and death cause in non-survivors of heart trauma

No.	AAST Classification	Surgical Thoracic aproach	Cardiac Injury	Associated Injuries	Cause of death
1	**I**	Bilateral	Pericardium, artery	Superior vena cava, lung, internal mamary artery	Hypovolemic Shock
2	**I**	Left	Pericardium	Spleen, lung, diafragm, pancreas.	Hypovolemic Shock
3	**III**	Sternotomy	Right ventricle, pericardium	None	Hypovolemic Shock
4	**IV**	Bilateral	Right ventricle	None	Hypovolemic Shock
5	**IV**	Left	Right ventricle	None	Hypovolemic Shock, consume coagulopathy, multiple organic failure
6	**IV**	Sternotomy	Right ventricule	Lung	Hypovolemic Shock
7	**III**	Left	Pericardium, right atrium, right ventricle	None	Hypovolemic Shock
8	**III**	Left	Pericardium, left ventricle	None	Consume coagulopathy, multiple organic failure
9	**III**	Left	Pericardium, left ventricle	None	Hypovolemic Shock
10	**IV**	Left	Right ventricle	None	Hypovolemic Shock

AAST: American Association of Surgical Trauma

Table 5. Variable behavior according to survival

Variable	Total (n=23) Md (15,75)	Survival SI (n=13) Md (15,75)	Non-Surviving NO, (n=10) Md (15,75)	p =
Age	26 (20,33)	26(18,33)	26 (21, 38)	0.367
Hydric Volume	3.5 (1.9, 5)	2.8(1.8, 3.5)	4.75 (4.5, 6)	0.001
Erytrhocyte concentrates	3 (2,4)	3 (2,3)	4 (3.25, 5)	0.002
Fresh plasma unities	2 (2,3)	2 (2,2.25)	3 (2,5)	0.042
Time until surgical treatment	40 (30,45)	40 (30, 45)	35 (30,40)	0.504
Days of intensive care unit stay	2 (0,5)	5 (2, 7.75)	0(0,1)	0.001

The surgical approaches in patients who survived vs patients who died were: left approach 14 [8(61.54%) vs 6 (60%)], bilateral 4 [2(15.39%) vs 2(20%)], sternotomy 3 [1(7.69%) vs 2 (20%)], combined 1 [1(7.69%) vs 0] and right 1 [1(7.69%) vs 0].

In Table 5, variables are accounted and grouped according to their characteristic of being alive or dead, median differences (percentile 25, 75), age, hydric volume, erythrocyte concentrates, fresh plasma unities utilized, time until surgical treatment, and length of stay in the intensive care unit.

The correlated variables were the non-surviving patient's vs type of injury (FP r=0.690, p=0.0001. Furthermore, we associated a major requirement in hydric reanimation volume, ml r=0.724, p=0.0001, of globular concentrates, r=0.666, p= 0.01 and fresh plasma unities, r=0.433, p=0.039.

The surviving group had a greater time of intensive care unit stay r=0.724, p=0.0001, but also a less requirement of hydric volume in reanimation: r=-0.433, p=0.039, and of globular concentrates, r=0.042, p=0.050

Discussion

Cardiac penetrating trauma is associated with high morbidity and mortality. Emergency surgical approach is still considered the cornerstone in the treatment of these patients. The present study shows a patient series, during a 6-year period of experience in treatment of cardiac trauma in two trauma hospitals in Mexico City, which attend a mean population of 90,000 patients a year in the emergency department.

In this sample, we could observe that the majority of the patients were male of a mean age of 26 years, and the most frequent injury mechanism was by firearm projectile n=15 (65.22%). According to the Romero VF and cols series, the most affected were male patients, which coincides with our findings, but the mean age of presentation was of 34 years and the injury mechanism was predominantly by PO (75%). The contrast is that in the years 2003 to 2011 the affected population was older. Gender and PO injuries were similar, as informed by Blake DP and Cols [1], with PO injury in 89.5% of patients. In other hand, Isaza-Restrepo and Cols [2], in 2017 reported their experience with 240 patients treated in a hospital in Bogotá, Colombia; cardiac trauma was presented mainly in male subjects (96.2%) of a mean age of 27.8 with predominance of PO injury. In our experience, and in similarity to Colombian affected population was younger than in previous years. This suggests that currently in our country, there are more victims of firearm injuries, due to an increase to the access of firearms by the younger men.

The mortality in our case study case of 10 patients (45.4%), which had a predominance for FP in 8 and 2 in PO, in the 3 Mexican series previously informed, the mortality was of 12.2% [3], 5% [4], y 30.7% [5]. The predominance in gender was masculine and the mechanism of injury PO. In Bogotá series, the mortality was of 20.5% in the same gender and the same injury mechanism. This pattern in ascent in the mortality related to the years captured, had been previously observed in the American College of Trauma Surgeons records and the data base of the Emory Surgery Department [6], the first period comprehended from 1975-1985; second period 1986-1996, and period 3, 2000-2010 and were 27%, 22% and 42% respectively. There was a male gender predominance, 60% of the mechanism was PO and 40% FP, moreover, the mortality of the group in concordance to the period was 32%, 33% and 56% and the mortality for FP according to the period was 36%, 42% and 56% respectively. Which coincides to this pattern of presentation in our case series.

Female population in this series was affected less than male population, which coincides with results in other studies [2,3-19]. The attention time was similar in those who lived and died (37 and 35 minutes respectively), which establishes that the emergency protocols in these hospitals in Mexico City are adequately adapted to acting guidelines, and the attention time was not a factor that modified the patient´s outcome.

According to the injury grade categorized by the AAST, the grade III and IV was predominant in non-surviving patients; there were no differences in the type of elected surgical approach. The major experience in Mexico with the type of surgical approach [4-6,20], was the left anterolateral thoracotomy, for it allows an adequate heart exposure for its repair, and it does not require cardiopulmonary bypass [1,2,12,14-19,21,22]. Our population had no differences in the number of surviving and non-surviving patients.

Cardiac injuries of 2 or more structures were more frequent than those associated to other organ affections. In this series, the pericardium and the right ventricle were the most affected, and this pattern coincides to other reported series [2,3-6,9,11,14-19]. Moreover, pulmonary injury was the most commonly associated in the surviving group (38.4%) and the non-surviving group (20%). This result contrasts with the series reported by Khorsandi and Cols [14], in which the injuries most commonly associated to cardiac trauma were costal fractures (36.6%), meanwhile parenchymal pulmonary injury was reported in fourth place of frequency with 21.1%

For hydric reanimation, the use of intravenous fluids, fresh plasma unities and globular concentrates, was greater in non-surviving patients; variables that showed correlation with FP mechanism of injury. Lower volume requirement for hydric reanimation for the surviving patients, therefore related to the survival and higher time in the intensive care unit of 3.1 days, in our series the mean number of stay in the intensive care unit was of 5 days, meanwhile Izasa-Restrepo and Cols [2] reported a mean stay time in intensive care unit of 5 days (with a range of 1-30 days), and a time of intrahospital stay of 6 days (with a range 1-58 days). Finally, Khorsandi and Cols [14], reported a series that involved 146 cardiac trauma patients, reporting an intrahospitalary internment of 6 days. In our series, the cause of death, was mainly caused by hypovolemic shock secondary to injuries, and only two cases, caused by consume coagulopathy and multiple organic failure, which correlates to reports by other authors [2,4-6,14-19].

In regard to mortality predictors, in the report by Asensio JA, et al [10] analyzed the National Data Trauma Bank of the United States. They identified of 1,310,720 registered cases, 2016 (0.16%) patients corresponded to heart penetrating trauma. The mortality at the arrival to emergency services was of 2012, and 1894 survived enough time to be surgically intervened. Of these, 830 (46%) had a thoracotomy performed in emergency units and 783 (94.3%) died and the survival was of 47 (5.7%); 974 (54%) had a thoracotomy performed in an operation room, 346 (35.5%) died and 628 (64.5%) survived. By logistic regression analysis, it was identified that FP wounds 26.85 (IC 95%, 17.21-41.89), cardiopulmonary reanimation 3.65 (IC 95%, 1.53-8.69), absence of spontaneous ventilation 1.08 (IC 95%, 1.02-1.14), presence of abdominal injuries caused by firearms 2.58 (IC 95%, 1.26-5.26), orotracheal intubation in the emergency unit 1386.3 (IC 95%, 126-1525) and aortic clamping 0.18 (IC 95%, 0.11-0.281) as predictive mortality variables [21-27].

Study limitations

Within the principal observations of this study, it has a limitation in its universe number, its retrospective character and it being the experience of 2 trauma centers, limited to Mexico City. Nevertheless, it permitted the observation of changes in the characteristics of the patients with cardiac trauma in our city/country.

Conclusion

Cardiac trauma constitutes an entity of high growing mortality and requires urgent diagnosis and treatment. Despite the limitations in the present study, cardiac trauma occurs in younger populations than in previous years and is now caused by firearm projectiles. Similar to what is reported in series in other countries. On the other hand, the results of the surgical attention are consistent with those reported by other series.

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