

Penetrating cardiac wounds Evolution of diagnosis, treatment, and results over a 30 year period

OBJECTIVE Over the years, the causes, the diagnosis and the management of penetrating cardiac wounds have evolved. The objective of this study was to determine the impact of these changes upon the outcome of our patients, treated during the last 30 years. **METHOD** From January 1966 to December 1995, we have treated 294 patients, 102 during the first decade, 113 during the second decade and 79 during the last decade. The 113 patients treated during the second decade were stratified according to their blood pressure on their admission to the emergency service, into four groups. Group I, 29 patients with no blood pressure, group II, 70 patients with systolic arterial pressure ranging from 30 to 90 mmHg, group III, 8 normotensive patients and group IV, 6 patients whose systemic blood pressure was not recorded. **RESULTS** The mode of the cardiac injury and the clinical manifestations were similar between the three decades. However, the initial resuscitation was significantly different. Pericardiocentesis was performed in only 3% of the patients treated during the last decade, whereas in the previous two decades it was performed in 40% and 30% respectively. Emergency room thoracotomy increased from 17% and 20% during the first and second decades respectively to 35% during the last decade. The survival rates were similar during all three decades, 79% in the first, 73% in the second and 78% in the last decade. The overall mortality of all patients treated during the second decade was 27.4%. However, the mortality of the patients who arrested before thoracotomy was 88%, whereas, for those who did not arrest perioperatively, the mortality was 10.2%. The mortality of patients with bullet wounds, 36.1%, was higher than that of those with stab wounds, 23.4%. **CONCLUSIONS** This retrospective study indicates that a gunshot wound, unobtainable blood pressure and especially the occurrence of a preoperative or perioperative cardiac arrest are strong predictors for high in hospital mortality of penetrating wounds of the heart. It also shows that the various changes in the diagnosis and management of these injuries have introduced during the last 30 years had minimal impact on the outcome of the patients.

From Homeric times when penetrating cardiac wounds were first described, up to about a century ago, such wounds were considered lethal. In 1896, Paget¹ wrote in his book of Surgery, "Surgery of the heart has probably reached the limits set by nature to all surgery: No new methods and no new discoveries can overcome

the natural difficulties that attend a wound of the heart". Ironically, later that year, Dr Rehn² first successfully sutured a stab wound of the right ventricle.

Since then, the causes have changed and the diagnosis and management of penetrating cardiac wounds have evolved. The objective of this study was to deter

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Διαγνωστικές και θεραπευτικές
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περιόδου 30 ετών

Περίληψη στο τέλος του άρθρου

Key words

Cardiac wound
Cardiac tamponade
Penetrating wound

mine the impact of these changes upon the outcome of our patients treated during the last 30 years.

MATERIAL AND METHOD

The records of all patients with penetrating cardiac wounds, treated from January 1966 to December 1995, were reviewed; notations were made as to the mode of the injury, the clinical manifestations, the patients' response to initial resuscitation, the perioperative treatment and the outcome of the patients. During these three decades 294 patients treated, 102 during the first decade, 113 during the second decade and 79 during the last decade.

In order to elucidate possible predictors of hospital mortality, the 113 patients treated during the second decade were stratified according to their blood pressure on admission to the emergency service, into four groups. Group I, 29 patients with no blood pressure, group II, 70 patients with systolic arterial pressure ranging from 30 to 90 mmHg, group III, 8 normotensive patients, and group IV, 6 patients whose pressure was not recorded.

RESULTS

The demographic features of the patients and the mode of their cardiac injuries were not statistically different during the three decades (tbl. 1). The clinical presentation showed no significant dissimilarities between these three periods (tbl. 2). However, the initial management was significantly different between the first two decades and the last decade. Pericardiocentesis was performed in only 3% of the patients during the last decade, whereas in the two previous decades it was performed in 40% and 30% respectively. Conversely, emergency room thoracotomy increased for 17% and 20% during the first and second decades respectively to 35% during the last decade. These differences can be attributed to two major changes that were introduced in trauma services in the last decade. First, during the last decade, a most all patients' care was

Table 1. Demographic features of patients with cardiac trauma.

	1966-1975	1976-1985	1986-1995
Number of patients	102	113	79
Males	88 (86%)	101 (89%)	68 (86%)
Females	14 (14%)	12 (11%)	11 (14%)
Age (mean)	33.5	30 years	35 years
Age (range)	15-63	15-60 years	12-82 years
Stab wounds	56 (55%)	77 (68%)	53 (67%)
Gunshot wounds	46 (45%)	36 (32%)	26 (33%)

Table 2. Initial presentation in the emergency center of patients with cardiac trauma.

	1966-1975	1976-1985	1986-1995
<i>Number of patients</i>	102	113	79
<i>Systolic BP</i>			
>90 mmHg	8 (8%)	8 (7%)	21 (27%)
30-90 mmHg	60 (59%)	70 (62%)	34 (43%)
0-30 mmHg	32 (31%)	29 (26%)	24 (30%)
BP not recorded	2 (2%)	6 (5%)	
<i>Physical examination</i>			
Elevated CVP	61 (60%)	42 (37%)	50 (63%)
Distal heart sounds	42 (41%)	19 (17%)	56 (71%)
Unobtainable pulse	20 (19%)	21 (19%)	20 (25%)
Pulsus paradoxus	10 (10%)	7 (6%)	9 (11%)
<i>Clinical presentation</i>			
Cardiac tamponade	61 (60%)	53 (47%)	44 (56%)
Intrathoracic bleeding	20 (19%)	17 (15%)	3 (4%)
Tamponade and bleeding	7 (7%)	43 (38%)	32 (40%)
<i>Arrest in the emergency center</i>			
Yes	26 (25%)	24 (21%)	28 (35%)

CVP: Central venous pressure

provided by the trauma surgeons, the residents and a faculty member, who were in the hospital 24 hours a day. Second, during part of the last decade, cardiac ultrasound examinations to detect tamponade were performed in the emergency center, by a surgery resident (PGY 3 or higher), and/or an attending trauma surgeon, who had both completed an ultrasound training course.³ In spite of these changes however, the patient survival rates were similar during all three decades, 79% in the first decade, 73% in the second decade and 78% in the last decade.

Ten of the 29 group I patients improved hemodynamically after the initial treatment. Three of these patients arrested before thoracotomy and all three died in the operating room. Of the remaining 19 who did not improve, 11 arrested before thoracotomy and 10 of these 11 patients died. Three others of the 19 patients died during the perioperative and postoperative periods. The overall mortality for group I patients was 55.2% of the 70 patients in group II, 20 improved hemodynamically following the initial resuscitation and 19 of these remained stable until thoracotomy was performed and they survived. One patient arrested before thoracotomy and later died in the operating room. The remaining 50 of group II patients showed no clinical improvement before thoracotomy, and seven arrested be

fore thoracotomy, five of whom subsequently died. Additionally, six others died during surgery or postoperatively. Thus, the overall mortality for group II was 17%.

Three of the 8 patients of group III arrested before thoracotomy and died during surgery, giving an overall mortality for this group of 37.5%. None of the six patients of group IV arrested and all survived.

Thus, the overall mortality for the patients treated during the second decade was 27.4%. However, the mortality for the patients who arrested before thoracotomy was 88%, whereas for those who did not arrest perioperatively, the mortality was 10.2%. The mortality for patients with bullet wounds was higher, 36.1%, than that of patients with stab wounds, 23.4%.

DISCUSSION

Injury related causes of death consistently rank as the third or fourth leading cause of mortality per year in the United States.^{4,5} It is estimated that 9 million trauma injuries involve the thorax, accounting for approximately 250,000 hospital admissions annually.⁴ Furthermore, approximately 22% to 25% of trauma deaths are due to thoracic injuries.^{4,5} Despite the increasing sophistication of emergency medical services and rapid transportation to the hospital, 60% to 80% of cardiac injuries result in death at the scene of the injury or before arrival to a trauma facility.⁶⁻⁹ In addition, studies have shown that the survival of patients arriving alive at the hospital has not improved significantly during the 20 year period 1963–1983.¹⁰ Similarly, our study indicates that the overall in hospital survival of cardiac trauma victims has not changed significantly during the last 30 years.

Gunshot wounds, unobtainable blood pressure and cardiac arrest before thoracotomy, appear to be strong predictors for an unfavorable patient outcome. The mortality rate in our patients with bullet wounds to the heart was 39% versus 28% for those with stab wounds. This observation is in accordance with previously reported studies.¹⁰ The high mortality of gunshot wounds to the heart may be attributed in part to more severe injury to the heart, and especially to severe injury to other organs, which frequently accompanies cardiac wounds. Arsenio et al¹¹ and Ivatury¹⁰ have shown that the absence of blood pressure on arrival to the emergency center is a statistically significant predictor of a poor outcome. Our findings concur with those observations, and our study also shows that cardiac arrest prior to thoracotomy is the strongest predictor for a poor

outcome in patients both hypotensive and normotensive on arrival at the hospital. The mortality for our patients who did not arrest prior to thoracotomy was 10.9%, whereas the mortality for those who arrested was 88%.

The reason for the very limited success of resuscitation of these trauma victims, who had seemingly normal hearts before injury, once they have arrested prior to thoracotomy or even intraoperatively, is not clear. Initially, decrease of subendocardial perfusion and later decrease of both subendocardial and subepicardial perfusion has been shown to occur in experimental animals with cardiac tamponade.¹² Perhaps this is one of the causes of the difficulty in resuscitating the wounded hearts.

Considering the lack of significant improvement in the results of the management of penetrating cardiac wounds during the last three decades, what actions may result in a better outcome of these injuries? First, prevention of the occurrence of such wounds by improving the educational and socioeconomic status of our population and by better gun control, are the best steps: Second, more rapid and safe transportation of trauma victims from the scene of the injury to the medical facility: Third, immediate assumption of treatment of the trauma victims with cardiac injury by the physicians familiar with the pathologic physiologic and metabolic alterations resulting from such injuries, and experienced in the preoperative and intraoperative management of a metabolically deranged heart: Fourth, immediate thoracotomy and repair of the wound before cardiac arrest occurs: Fifth, elucidation of the causes of the low incidence of successful resuscitation of the patients who sustain cardiac arrest before thoracotomy, and of those who develop intraoperative ventricular fibrillation, may result in better methods of therapy.

In summary, this retrospective study indicates that the various changes in the diagnosis and management of penetrating cardiac wounds that have been introduced during the last 30 years have had minimal positive impact upon the outcome. It also demonstrates that a gunshot wound, unobtainable blood pressure on admission and especially the occurrence of preoperative or perioperative cardiac arrest are strong predictors for high in hospital mortality of penetrating wounds of the heart. Reduction of these risk factors or better yet, prevention of these injuries should result in a decrease of the mortality from cardiac trauma.

ΠΕΡΙΛΗΨΗ

Διαπαινούσες κακώσεις καρδιάς. Διαγνωστικές και θεραπευτικές εξελίξεις και αποτελέσματα, περιόδου 30 ετών

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ΣΚΟΠΟΣ Τα τελευταία χρόνια παρατηρούνται σημαντικές εξελίξεις στη διάγνωση και θεραπευτική αντιμετώπιση των διαπαινούσων κακώσεων της καρδιάς. Σκοπός της μελέτης μας ήταν να διερευνηθεί η επίπτωση των εξελίξεων αυτών στην τελική έκβαση των ασθενών με διαπαινούσα καρδιακή κάκωση, που αντιμετωπίσαμε σε περίοδο 30 ετών. **ΜΕΘΟΔΟΣ** Από τον Ιανουάριο 1966 μέχρι το Δεκέμβριο 1995 αντιμετωπίσαμε συνολικά 294 ασθενείς, 102 κατά την πρώτη, 113 κατά τη δεύτερη και 79 κατά την τρίτη δεκαετία. Οι 113 ασθενείς της δεύτερης δεκαετίας ομαδοποιήθηκαν σε 4 υποομάδες, ανάλογα με την αρτηριακή πίεση κατά την προσαγωγή τους στο νοσοκομείο. Ομάδα I, 29 με μηδενική πίεση, II, 70 με συστολική αρτηριακή πίεση 30-90 mmHg, III, 8 με φυσιολογική αρτηριακή πίεση και IV, 6 ασθενείς, των οποίων η αρτηριακή πίεση δεν καταγράφηκε. **ΑΠΟ ΤΕΛΕΣΜΑΤΑ** Το είδος της καρδιακής κάκωσης και οι κλινικές εκδηλώσεις της βλάβης ήταν παρόμοιες και στις τρεις δεκαετίες. Η αρχική, ωστόσο, αντιμετώπιση παρουσίαζε σημαντικές διαφορές. Περικαρδιοκέντηση έγινε μόνο στο 3% των ασθενών που αντιμετωπίστηκαν την τελευταία δεκαετία, ενώ αναφέρθηκε στο 40% και 30% των ασθενών των προηγούμενων δεκαετιών. Επείγουσα θωρακοτομή στα εξωτερικά ιατρεία, από 17% και 20% στην πρώτη και δεύτερη δεκαετία, αυξήθηκε στο 35% την τελευταία περίοδο της μελέτης. Τα ποσοστά επιβίωσης ήταν παρόμοια και τις τρεις δεκαετίες που εξετάστηκαν, 79% την πρώτη, 73% τη δεύτερη και 78% την τελευταία. Η συνολική θνητότητα των ασθενών που αντιμετωπίστηκαν τη δεύτερη δεκαετία ήταν 27,4%. Εντούτοις, η θνητότητα αυτών που υπέστησαν καρδιακή ανακοπή προ της θωρακοτομής ήταν 88%, ενώ αυτών που δεν υπέστησαν ανακοπή ήταν μόλις 10,2%. Η θνητότητα των ασθενών με κάκωση από σφαίρα ήταν 36,1%, υψηλότερη της θνητότητας 23,4% αυτών με κάκωση από μαχαίρι. **ΣΥΜΠΕΡΑΣΜΑΤΑ** Η αναδρομική αυτή μελέτη δείχνει ότι κάκωση από πυροβόλο όπλο, χαμηλή αρτηριακή πίεση και, κυρίως, επεισόδιο προ ή διεγχειρητικής καρδιακής ανακοπής αποτελούν ισχυρούς προγνωστικούς παράγοντες υψηλής ενδονοσοκομειακής θνητότητας σε ασθενείς με διαπαινούσες κακώσεις καρδιάς. Επίσης, αναδεικνύει ότι οι σημαντικές διαγνωστικές και θεραπευτικές εξελίξεις των τελευταίων 30 ετών δεν προκάλεσαν αξιόλογη βελτίωση στην τελική έκβαση των ασθενών αυτών.

Λέξεις ευρετηρίου: Διαπαινούσες κακώσεις, Κακώσεις καρδιάς, Καρδιακός επιπωματισμός

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