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Mediastinitis after open heart surgery

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Abstract: Background: Infectious mediastinitis is a relatively uncommon but potentially devastating complication occurring after median sternotomy. In a survey of most recent studies, the incidence of deep sternal wound infection has plateaued at 0.4% to 4% several risk factors for developing infectious mediastinitis after cardiac operations have been categorized to preoperative during and postoperative factors. **Methods**: This survey is performed prospectively in Tabriz Shahid Madani Hospital (center of cardiac surgery) between (October 2000- october2004) to detect of suppurative mediastinitis incidence and treatment modalities, outcome of patients and compare with another survey between 1996-2000in this center. **Results**: Among 2844 case of open heart surgery, suppurative mediastinitis has been observed in 26 patients (0.9%) , among these 26 patients, the mean age was 60.15± 9 and the male / female ratio was 0.36. Among these 26 patients, 10 cases (38.5%) had diabet mellitus, 14 cases (53%) had hypertension, 7 cases (27%) had over weight, 10 cases (38.5%) had obesity, 11 cases (42%) were smoker, and 5 cases (19.24%) had history of myocardial infarction. Among all of etiologic agents responsible for suppurative mediastinitis, Staphylococcus aureus was in first rank and Pseudomonas aeruginosa was in second rank. Clinical findings in the time of mediastinitis diagnosis were consisting of: Fever, pus discharge, instability of sternum, local erythema and chest wall pain. **Conclusion**: incidence of suppurative mediastinitis after open heart surgery between October 2000 to October 2004, and gram negative bacilli as etiologic agent in comparison with 4 years ago in this center has increased.
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Key Words: Suppurative Mediastinitis, Sternotomy, Predisposing Factors, Etiologic Agents,Open Heart Surgery

Introduction

Purulent mediastinitis caused after open cardiac surgery is an important complication which has an incidence of 0.4 to 2.4% according to the existing statistics (1). Previous research introduced a large number of predisposing factors involved in the development of post-operative mediastinitis. These factors are classified into three groups which include pre-operative factors, post-operative factors, and intraoperative factors. The biological factors involved in postoperative purulent mediastinitis include bacteria and fungi while the major cause of purulent mediastinitis is gram-positive cocci. The role of fungal factors is also slight. The patterns of biological factors introduced in reports by different centers are varied (2) and it is better to study the patterns for each center separately. From the diagnostics point of view, it shall be mentioned that the clinical guesses of physicians are extremely important while infections may be asymptotic in the early stages. Purulent mediastinitis caused by cardiac surgery calls for a combination of medical (antibiotics) and surgical treatments (1-5) which should be started immediately after diagnosis. In order to have definite culture results the initial antibiotic treatment should be empirical and shall provide covering with gram negative seals and gram positive cocci (1). Regarding the mortality caused by this condition it shall be said that infections associated with deep wounds that appear after sternotomy can lead to a mortality of up to 50% (2). Treatment costs of

infectious mediastinitis are high. Moreover, prolonged synthetic ventilation, repeated surgeries and prolonged residence in ICU and hospitals also make hospitalization costs double or triple. Patients are also exposed to more risks of cardiac complications (2).
The aim of this study was evaluation of suppurative me diastinitis after open heart surgery.

Materials and Methods:

In a cross-sectional descriptive-analytical study which was carried out in the infectious diseases department of Tabriz University of Medical Science patients with cardiac conditions who were subjected to open cardiac surgery were examined for the incidence of purulent mediastinitis.

This research was carried out from 2000 to 2004 for 4 years. The study group included patients who went through midline sternotomy for cardiac surgery. The patients were subjected to midline sternotomy either electively or urgently.

Preparation of patients for surgery:

The night before surgery the chest hair of the patients was shaved and their skin was cleansed with povidone iodine in the operating room before the surgery. The surgeries were also performed by the honorable professors working in the cardiac surgery section with the aid of residents of the same unit using standard techniques. For the purpose of pharmaceutical prevention 1 grams of intravenous Cefazolin (IV) was administered 30 minutes before the operation and later on every 4 hours during the operation and every 6 hours after the operation for 48-72 hours. In a number of patients the duration of infusions was higher and sometimes depending on the situation antibiotics such as Vancomycin or Cefazolin were also administered with Gentamicin.

Following the surgery mediastinal drains that were connected to a closed or vacuum system were used to discharge the secretions of chest wounds. Patients were immediately transferred to the ICU from the operating room.

The procedure for selection of patients:

This study was carried out on patients who received infection consultation after open cardiac surgery in the cardiac ICU unit because they were suspected of infectious complications.

Among these patients, patients who met one of the following criteria were selected as patients with deep infection of sternal wound and the rest of the patients were excluded as patients with superficial soft tissues infections.

1. Sternal instability with evident purulent secretions from the sternal wound
2. Sternal instability with positive culture of sternal wound secretions
3. Sternal instability with positive blood culture
4. Chest pain with positive culture of sternal wound secretions
5. Chest pain with evident purulent secretions from the sternal wound
6. Chest pain with positive blood culture
7. Body temperature of ≥ 38 with evident purulent secretions from sternal wound
8. Body temperature of ≥ 38 with positive culture of sternal wound secretions
9. Body temperature of ≥ 38 with positive blood culture

Patients who met one of the above criteria were candidates for re-opening of their surgical wounds. After the surgical wound of a patient was re-opened the patient would be selected as a mediastinitis patient if apparent evidence showed the existence of mediastinal infection. Patients with sternal osteomyelitis but without mediastinal involvement were excluded. After selecting patients with purulent mediastinitis after open cardiac surgery was selected the required information was obtained.

Statistical Analysis:

The collected data were analyzed by SPSS-17 statistical software. The collected data were expressed as percentage and mean ± SD. Continuous (quantitative) variables were compared by Independent samples and Paired t test. Categorical (qualitative) variables were compared by contingency tables and Chi-square test or Fisher's exact test. P-value ≤ 0.05 was considered statistically significant.

Results:

Purulent mediastinitis was observed in 26 instances (0.9%) out of the total 2844 open heart surgeries. The cause of sternotomy in the patients with purulent mediastinitis was CABG in 20 instances (76.9%), MVR+CABG in 2 instances (7.69%), ASDR in 1 instance (3.84%), MVR in 1 instance (3.84%), AVR in 1 instance (3.84%), and MVR+CABG+AVR in 1 instance (3.84%).

The mean age of the suffering patients was 60.15±9 years, and the male-female ratio was 1.36:1.

10 instances (38.5%) were diabetic patients, 14 instances (53%) had HTN, 9 instances (35%) pre-surgery creatinine > 1.2 mg/dl, 11 instances (42%) smoking history, and 5 instances (19.2%) myocardial infarction history.

The mean pre-surgery LVEF was 47.5±10%, including 17 instances (65%) over 40% and 9 instances (35%) below 40%. None of the patients had antibiotic treatment history, endocarditis history, or pre-surgery steroid reception or immunosuppressive history. In 21 instances (80.76%) elective surgery and in 5 instances (19.24%) emergency surgery was performed. The mean pre-surgery hospitalization time was 7.46±3 days.

14 instances (53%) out of these 26 surgeries have been on-pump and 12 instances (47%) beating-heart surgeries. The mean pump use duration has been 121±46 minutes, and low cardiac output conditions had occurred in no instances when removing the pump.

The mean aortic clamp duration in the on-pump instances was 65±30. In all of the instances of CABG unilateral IMA and in 1 instance (4.5%) bilateral IMA had been used. The mean mechanical ventilation time before mediastinitis diagnosis was 23.65±1830 hours, the mean ICU hospitalization time before mediastinitis diagnosis was 4.21±2 days, and the mean time period between heart surgery and occurrence of mediastinitis was 16±5 days.

The mean number of blood units used in the ICU after surgery was about 2 units, and in 4 instances, that is, 15.38%, more than 1000 cc of blood had been used. In 1 instance (3.84%), balloon pumps had been used in the ICU. The clinical findings when diagnosing mediastinitis included fever in 22 instances (84%), purulent discharge in 21 instances (80%), sternal instability in 6 instances (23%), local erythema in 2 instances (7.6%) , and chest pain in 1 instance (3.84%).

The mean leukocytosis was 12840 per cubic millimeter (mm^3) (6200-21000) with 78% (65-90%) neutrophilia. The blood cultures were positive in one instance. Of the total number of the bacterial and fungal agents involved in the purulent mediastinitis, 9 instances (34.61%) were Gram-positive agents, 8 instances (30.76%) Gram-negative agents, 1 instance (3.84%) a mixture of Gram-positive and Gram-negative bacterial agents, 1 instance (3.84%) fungal agents, 1 instance (3.84%) a mixture of fungal and bacterial agents, and 1 instance (3.84%) uncommon bacterial agents, and there were 5 instances (19.23%) of negative cultures.

Among the Gram-positive agents, 7 instances (77.77%) included staphylococcus aureus, and 2 instances (22.23%) staphylococcus coagulase-negative (CONS). Among the Gram-negative agents, 5 instances (62.5%) included pseudomonas aeruginosa, and 3 instances (37.5%) Enterobacteriaceae cloacae. The one instance of fungal agent included Candida Albicans. The one instance of uncommon bacterial agent included Nocardia Asteroides. The 1 instance of Gram-negative and Gram-positive mixture included a mixture of staphylococcus aureus and Acinetobacter, and the 1 instance of fungus and bacteria mixture included a mixture of gr- bacillus and Candida.

As with the Gram-positive agents' antibiograms, regarding staphylococcus aureus, the antibiogram was not available in the file in one instance, and all the remaining 6 instances were sensitive to Vancomycin (100%) and 3 instances (50%) were sensitive to first-generation cephalosporin. And regarding staphylococcus coagulase-negative, both occurring instances (100%) were sensitive to Vancomycin, one instance (50%) was first-generation cephalosporin resistant, and one instance (50%) was sensitive to first-generation cephalosporin.

As with the Gram-negative agents, among the 3 instances of Enterobacteriaceae cloacae, there was not an antibiogram in one instance, 2 instances out of these three (66.66%) were sensitive to Aminoglycoside and Fluoroquinolone, and 1 instance (33.24%) was sensitive to Fluoroquinolone, Aminoglycoside, and third-generation cephalosporin. The types of the antibiotics used in empirical treatment until the culture results were obtained included 2 instances (7.69%) of mere Vancomycin, 3 instances (11.53%) of Vancomycin + Aminoglycoside + third-generation cephalosporin, 1 instance (3.84%) of Clindamycin + third-generation cephalosporin, 2 instances (7.69%) of third-generation cephalosporin + Vancomycin, and 18 instances (69.2%) of Vancomycin + Aminoglycoside. Of all the instances of purulent mediastinitis for which empirical treatment had begun, the results were right in 17 instances (65%). From the point of view of the treatment methods, in 19 instances (73%) open wash-out with delayed healing and in 7 instances (27%) closed wash-out after debridement had been performed. The mean venous treatment duration following mediastinitis diagnosis was 3.5±1.5 weeks (2-6 weeks). The mortality rate was 4 instances (15.3%).

Discussion:

During the past 50 years, midline sternotomy has been the standard approach in heart surgery (2), and in recent studies, the incidence of infections related to deep sternal wounds occurring during open heart surgery has been reported as 1-4%, and during hospital out-breaks, the incidence of post-surgery purulent mediastinitis even reaches 23.7%. In view of the lack of equal guide-lines for specification of these infections' intensity and extent, however, specifications of these infections' actual incidence from different centers do not match, and after all, these infections' actual incidence is considered as less than 2% (2).

Cheung and colleagues demonstrated that mediastinitis occurs more in valve surgery (6). In Grmolje's study, however, among 10 instances of post-surgery mediastinitis, 9 have followed CABG, and only one has followed MVR (7).

In our study, 80% of the purulent mediastinitis had occurred following CABG.

An age over 64 years has been considered as a risk factor (8), and as for gender, Burger and colleagues (2000) suggested the male gender as a risk factor (9), but in Breyer's study, high incidence has been reported for mediastinitis in the female gender (10).

In our study, the male-female ratio was 1/1.36, and the patients' mean age was 60±9 years.

The risk factors for purulent mediastinitis include DM, obesity, RF, smoking, COPD (10), HTN, AMI one month before surgery (11), low cardiac output, long hospitalization, and emergency surgery (8).

In our study, 38.5% of the instances had DM, 65% obesity, 35% Cr > 1.2 mg/dl, 42% smoking history, 53% high blood pressure, and 20% AMI history.

In regard to the bacteriology of mediastinitis, it should be stated that in most centers, SGN covers 35-50% of infections after heart surgery, staphylococcus aureus' share is 25-35%, and G^- bacilli cover 3-18% of instances (2).

In Ottin's study, pseudomonas aeruginosa was the most prevalent organism responsible for occurrence of mediastinitis after heart surgery (12).

The type of microorganism involved in purulent mediastinitis after open heart surgery is affected by some factors (1). For example, in cases where purulent mediastinitis is due to dirt around the surgery, it usually results from staphylococcus aureus, and when mediastinitis results from infection extended from other sources during the post-surgery phase, G^- bacillus agents are mostly involved. Moreover, the host's property can also affect the type of agent involved; for example, in cases where purulent mediastinitis has been accompanied by obesity, COPD, and sternal opening, the major etiologic agent has been SGN (2).

The most prevalent clinical manifestations of patients with purulent mediastinitis after heart surgery include fever, abnormal appearance of the surgery wound, erythema and cellulite or purulent discharge, and sternal instability, wound opening, and bubbles coming out of the sternal wound rank next (2).

Besides the clinical manifestations mentioned, patients with purulent mediastinitis after heart surgery demonstrate changes like erythema, cellulite, purulent drainage, sternal sensitivity, and sternal relaxing. The physician must carefully monitor the patient's status, and any increase in the pain intensity must also make him suspicious to occurrence of purulent mediastinitis after open heart surgery (2). In general, fever, abnormal appearance of the surgery wound, and erythema and cellulite or purulent discharge are more prevalent than sternal instability, wound opening, and bubbles coming out of the sternal wound (3).

In our patients, too, the most prevalent clinical manifestation was fever and purulent discharge.

A moderate leukocytosis with a shift to the left and ESR increase are symptoms the occurrence of which can lead one to guess infectious complications. CXR can demonstrate widening of the mediastinum with a fluid-air level, subcutaneous emphysema, or mediastinal emphysema. Particularly, lateral graphies can demonstrate gas in upper mediastinum, and 50% of instances of pneumomediastinum cannot be diagnosed without lateral graphies. In general, it should be said that simple x-graphics plays a minor role in diagnosis of purulent mediastinitis after heart surgery. CT scan can aid diagnosis in cases where simple chest graphy is not effective, and it is the most valuable imaging method and technique in distinguishing mediastinitis from surface infections as well as mediastinitis caused by loculated mediastinal infection (10). CT scan has a sensitivity of 67% and a property of 71%. CT scan demonstrates concomitant or adjacent infections like empyema, phrenic abscesses, and cervical tissue infection (3), and it can specify involvement or noninvolvement of the aortic wall, the cardiac cavities, or the bypass closures (4).

From the point of view of diagnosis, it should be said that the physician's clinical guess is very important in diagnosing purulent mediastinitis after open heart surgery (2). In the first phases, infections may not be accompanied by clear pus, and there may even be no fever or leukocytosis. Any purulent discharge or even increase in the patient's pain in the surgery wound can warn of the occurrence of this infection.

From the point of view of use of antibiotic treatment, empirical treatment covering staphylococcus and B-G^- must begin until the definite culture results are prepared (13). There is not an agreement on the antibiotic treatment length. A group of authors recommend injection treatment for 3 months, and some recommend continuation of treatment in the oral monotherapy form for 9 months. But in general, the type of organism involved, the initial treatment response assessment mediastinitis phase, and using or not using a muscle or omentum flap are effective on the antibiotic treatment period length. Treatment failure is more frequent in cases where mediastinitis is caused by MRSA (methicillin-resistant staphylococcus aureus).

Although there is interest in adjunctive therapies like intravenous immunoglobulin, but few studies have been performed (1).

In our study, of the total 26 instances of purulent mediastinitis after open heart surgery, in 19 instances, that is, 73%, open wash-out with delayed healing and in 7 instances, that is, 27%, closed wash-out after debridement was performed. Furthermore, in 70% of the instances, the empirical diet included Vancomycin + Aminoglycoside. Of all the instances for which empirical treatment had begun, the treatment responses were right in 65% of the instances. The mean duration of intravenous antibiotic use following mediastinitis diagnosis was 3.5 weeks.

As for the type of antibiotic prophylaxis, Cefazolin and Cefixime are the choice drugs. However, in cases where Vancomycin has been utilized as chemoprophylaxis, infection has been extraordinarily less, but it is to be utilized when staphylococcus and Vancomycin-resistant Enterococcus are there at the surgery center.

Carrying staphylococcus aureus in the nose is a major risk factor among post-surgery infections, and use of nasal mupirocin decreases sternal infections after heart surgery (14). It is suggested that nasal swab culture be performed on hospitalized patients, and treatment with mupirocin and use of Vancomycin for prophylaxis be in order if the culture is positive. Use of the rigid-plate-fixation technique is of importance in reduction of infections (15). In this technique, one makes sure there is no sternal movement, and use of sternum acts as prophylaxis against mediastinitis.

The mortality and morbidity resulting from mediastinitis is high, and it has reached 30-50% in some studies, but the mortality rate has been reported as lower than 10-15% in new studies (2).

The mortality rate in our study was also 15.3%.

The major factors for specification of prognosis include the time of infection diagnosis and that to begin proper treatment for the patient (3), and the other indicators of prognosis include the blood BUN level, the number of the WBCs and positive B/C, the surgery recovery method, and CMV excretion.

Conclusion:

Purulent mediastinitis after open heart surgery is an uncommon complication that usually occurs 2-4 weeks after surgery, and causes extension of time of hospitalization and intensive care, and in view of the need for surgical interventions and prolonged antibiotic use, it causes an increase in mortality and morbidity and a rise in treatment costs. The factors involved in occurrence of purulent mediastinitis after heart surgery include ones before, during, and after surgery, and it is thought that occurrence of the complication can be prevented by identifying and being aware of these factors and seeking to control them.

The incidence of purulent mediastinitis after heart surgery at Shahid Madani Education and Treatment Center in Tabriz between 2000 and 2004 was 0.9%. From the point of view of the factors involved, in the investigation available (79-83), the most prevalent agent is staphylococcus aureus, and pseudomonas aeruginosa ranks next. The mortality of the patients with purulent mediastinitis was 15.3%.

Suggestions:

It seems that efforts made in the area of identification of preventive methods and provision of facilities for them according to the conditions at any heart surgery center and investigation of the problems and constraints on the way are effective on maximal reduction of instances of mediastinitis. And in view of the fact that increase in prevalence of mediastinitis with $B\text{-}G^-$ at one center is a warning of a dirty environment and dirty tools used and probable failure in proper control of their sterilization, changes in and improvement of the conditions of operating rooms will cause a considerable decrease in occurrence of mediastinitis resulting from $B\text{-}G^-$. Moreover, as carrying staphylococcus aureus in the nose is a major risk factor among post-surgery infections, it is suggested that nasal swab culture be performed on hospitalized patients, and treatment with mupirocin and other suitable medications for prophylaxis be performed if the culture is positive.

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