

DEEP WOUND INFECTIONS (MEDIASTINITIS) AFTER OPEN HEART SURGERY

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Abstract: Deep wound infections are a serious complication after open heart surgery and are directly related to patient survival both in the short and long term. Despite prevention, their appearance continues to be significant - 0.5% - 6.8% and the associated in-hospital mortality ranges from 7% to 35%. Analysis of the clinical material concerning the development of mediastinitis after cardiac surgery with total median sternotomy and cardiopulmonary bypass, reporting the results from the applied surgical methods, as well as consideration of prevention options, such as biomarkers – procalcitonin (PCT) and C-Reactive protein (CRP), and early diagnosis of these potentially life-threatening complications. The report presents 7- year experience of the Cardiac surgery department with prophylaxis, diagnosis and treatment of patients who develop deep wound infections after open heart surgery covering the period of January 2011 to January 2018. For this period 4563 patient with different types of cardiac pathology we operated, 94 (2.06%) of them developed deep wound infection. Patients are divided into groups depending on the type of surgery – CABG, valve correction, aortic surgery or combined procedures. The study is retrospective, and the clinical data used is from the hospital records. Sex ratio is 1,5:1 – males/females. The mean age for both sexes is 67.5 years. In hospital mortality was evaluated - 22.34% (21 patients). In 100 of the patients PCT and CRP were tested during the first postoperative day. 15 of them PCT was more 2 ng/ml and 9 (60%) patients developed deep wound infection. In all these patients, bacterial agent was isolated from wound and vacuum-assisted therapy was used. In 2 cases we used titanium plates for sternal reconstruction along with mobilization of omentum majus. Despite the progress of surgical techniques and the minimally invasive techniques, the rate of development of deep wound infections remains relatively high. The use of vancomycin paste, gentamicin-impregnated sponges, reducing the use of sternal wax and excessive cauterization of tissues seems to be a preventive measure. Evaluation of PCT And CRP on POD-1 proves to be an effective prognostic marker for the development of infectious complications. The data presented in the report is comparable to those reported in the world literature. Open heart surgery with cardiopulmonary by-pass leads to a risk of developing mediastinitis. Improved surgical techniques and research on specific biomarkers could reduce the development of this life-threatening complications.

Keywords : Open heart surgery, extracorporeal circulation, deep wound infection, biomarkers

INTRODUCTION

Deep wound infections are a serious complication after open heart surgery and are directly related to patient survival in the short and long term. Despite prevention, their expression remains significant from 0.5% to 6.8%, and associated hospital mortality ranges from 7% to 35% . By the end of the first year, Filsoufiet et al. found an absolute difference in survival between patients without deep wound infections and those who developed this complication. At a 10-year follow-up for patients operated for coronary artery disease, the survival rate for those who developed mediastinitis was postoperatively 39%, compared to 70% of those who had no complications .Treatment costs are also increasing, mainly due to additional antibiotic treatment and surgical procedures such as vacuum assisted therapy, as well as increased length of hospital stay .For many years, researchers have tried to find biochemical markers of inflammation with both diagnostic and prognostic significance. The most commonly used markers in daily practice are erythrocyte sedimentation rate (ESR), leukocyte count, differential white blood cell count, C-reactive protein (CRP) and procalcitonin (PCT) levels. .We believe that the information of biochemical markers will allow early detection of septic complications prior to clinical manifestation. These data may contribute to the modification of therapeutic management and earlier indication for aggressive surgical treatment, administration of more effective antibiotic therapy, and improvement of the rehabilitation program, which may reduce mortality.

MATERIALS AND METHODS

This retrospective study was conducted in the Department of Cardiac surgery at University Hospital "St. George " - Plovdiv, Bulgaria. From January 2011 to January 2018, a total of 4,563 patients were operated and included in the study. In all of the patients total midline sternotomy was performed. Operations include coronary artery bypass

grafting (CABG), valve corrections, operations for acute aortic syndrome and combined procedures. Preoperative preparation consists of shaving and washing the body of the patient twice with Skinsept solution before the intervention. In the operating theatre, the operative field is treated with 1% iodine in 70% alcohol solution (Braunoderm) or chlorhexidine in 70% alcohol solution in case of iodine allergy. Antibiotic prophylaxis consists of an application of cefazolin (2 g iv immediately before the incision and then three times 1 g iv every 6 h). Extended 24-hour prophylaxis with cefazolin is applied if a revision of the patient was performed and second antibiotic is added if indicated. The operative field is covered with antimicrobial incise drapes (Ioban). The sterile gloves of the surgical team are replaced every time before graft or valve preparation. In sternotomy, the use of wax and excessive cauterization are avoided unless there is a serious need for hemostasis. Prior to osteosynthesis of the sternum, the latter is treated with vancomycin paste, which consists of 4 flacons of Vancomycin and saline solution. In obese patients, we apply the Robicsek technique for sternal osteosynthesis (Figure 1). The subcutaneous tissue is closed with single absorbable sutures and irrigated with Gentamycin solution. Each patient is monitored within 90 days of discharge, following specific control and prevention criteria.

According to them, the definition for deep wound infection requires: positive microbiological results from the surgical wound; suppuration of the operative wound; fever; chills; elevated CRP; leukocytosis; instability of the sternum with bone crepitus; positive hemocultures. Of all 4563 patients operated in our institution, 94 (2.06%) developed mediastinitis with a proven microbiological agent. The patients with diabetes and those who underwent surgery for CAD or combined procedures represent the highest percentage. Patients with suspected deep wound infection at examination - wound suppuration, wound odor, fever, deviations from laboratory parameters (leukocytosis, increased CRP and PCT) are immediately hospitalized. Wound debridement is performed and materials for microbiological testing are sent. In case of sepsis or septic shock, the patient is isolated in a special intensive care room. The wire osteosynthesis is removed, and a device for negative pressure (vacuum assisted therapy) is placed. Empirically dual antibiotic therapy is initiated until the results from microbiology arrive.

MICROBIOLOGICAL ISOLATES

A microorganism was isolated in 89 of the patients who developed mediastinitis: *Staphylococcus aureus* (35%); *Enterococcus faecalis* (13.5%); *Acinetobacter baumannii* (11.5%); *Staphylococcus epidermidis* (9.0%); *Escherichia coli* (7.7%); *Klebsiella pneumoniae* (5.3%); *Proteus mirabilis* (2.4%); *Enterobacter cloacae* (8.6%); *Bacteroides fragilis* (3.4%); other coagulase - negative staphylococci (3.6%). *Acinetobacter baumannii* has been causing serious problems for cardiac surgeons and anesthesiologists in recent years due to its increased resistance. It is the main cause of ventilator-associated pneumonia in patients with prolonged mechanical ventilation.

PREDICTIVE BIOMARKERS

In 100 (91 men and 9 women) of the patients, we tested procalcitonin and C-reactive protein levels 12 hours after surgery. The average CRP values in the study are 86.05 mg / dl (41.1 - 128). It is well known that conditions of extracorporeal circulation have an immunomodulatory effect and there may be slight increases in both parameters. In the follow-up period a gradual decline in the values is observed and complications develop if the CRP values remain beyond 100 mg / dl, 1-2 weeks after surgery and are usually associated with pulmonary infections. Two of the patients with CRP > 85 mg / dl developed a deep wound infection. In the procalcitonin study, 15 of the patients had values above 2 ng / ml, which according to some authors is considered a prognostic value for the development of infectious complications. Of these, 9 (60%) have developed mediastinitis, and one of the patients with PCT-levels of 6.55 ng / ml developed fulminant septic shock with lethal outcome. From the other 15 - 2 patients developed pneumonia, 1 developed sepsis with multiple organ failure syndrome, and the remaining 3 patients showed no signs of infections with normal postoperative period.

WOUND INFECTIONS AND TYPE OF SURGERY

Significantly more common in coronary patients with diabetes and use of both internal thoracic arteries, where the blood supply of the sternum is significantly reduced and the healing of the sternum is compromised. In our series of 10 patients with BIMA, 4 of them developed mediastinitis. This complication can be reduced by using the skeletonized technique, which is not routinely used in our institution because of the higher risk for graft damage. Higher risk for infectious complications is observed in the cases of combined surgical interventions with prolonged CPB-time, CABG+ Double/Triple valve or the operations for AAS. From 94 patients who developed mediastinitis, 10 of them were performed as urgent operations.

MORTALITY

22.34% (21 patients) died within the 90 days of follow-up period. In 9 of the patients, the cause of death was septic shock with multiple organ failure, pulmonary thromboembolism - in 4 patients, stroke – in 6 patients, respiratory failure – in 1 patient and 1 patient died due to rupture of right ventricle from bone fragment of the sternum.

DISCUSSION

The incidence of mediastinitis after cardiac surgery has been reported differently between 0.5% and 6.8%. This postoperative complication is serious, with mortality varying between 7% and 35% in the various series of cardiac surgery patients. Postoperative deep wound infections are associated with a very high rate of early postoperative mortality. According to different authors, as in our report, the risk for this type of complication is higher in combined procedures with prolonged duration of ECC, as well as in operations for myocardial revascularization using both internal thoracic arteries. In aortic surgery (dissections and aneurysms), the use of synthetic prostheses and deep hypothermia with circulatory arrest may also contribute for the development of mediastinitis. These results indicate that the prevention of post-operative deep wound infections and the establishment of appropriate treatment for them are important factors in reducing mortality after cardiac surgery. Large retrospective studies have identified the epidemiological factors associated with the development of mediastinitis. As main risk factors stand out: advanced age, obesity, diabetes, smoking, BIMA at CABG, patients on hemodialysis, reoperation, prolonged CPB-time. Patients requiring postoperative revision are at higher risk of complications, morbidity and mortality. In our study, the incidence of revisions was 12%. Patients requiring reexploration are at increased risk of blood transfusion reactions, viral and bacterial infections.

Canadyova et al. report that the risk factors associated with higher in-hospital mortality after reexploration due to bleeding and tamponade lead to higher levels of lactate, prolonged mechanical ventilation, the need for catecholamines and blood transfusions. Significant risk factors for revision for bleeding after cardiac surgery are low ejection fraction, high EuroSCORE, procedures other than isolated CABG, prolonged cardiopulmonary bypass time, low body mass index, diabetes mellitus and renal failure. The latter had a significant increase in postoperative creatinine and higher mortality.

Deniz et al. study the effectiveness of vacuum-assisted negative-pressure therapy compared to conventional methods of treating postoperative mediastinitis after open heart surgery in 90 patients. As 90-day mortality was significantly lower (8.5% versus 23.2%) and overall 1-year survival was significantly better (91.5% vs. 76.7%) in the vacuum-assisted therapy than in the conventional treatment group concluded that negative pressure in the mediastinum is a safe and reliable option with excellent survival and low failure rates compared to conventional treatment. Sachithanadan et al. assessed the impact of deep wound infections on hospital mortality and mid-term survival after cardiac surgery in 4586 adult patients who underwent cardiac surgery with median sternotomy. The wound complications requiring a surgical revision are 1.65%. Age, diabetes smoking and prolonged mechanical ventilation have been identified as independent predisposing factors for mediastinitis. These patients are more likely to develop renal failure and often require a tracheostomy postoperatively. In our series, all patients were treated with vacuum assisted therapy (Figure 2,) and in 2 patients we implanted titanium plaques with omentum majus mobilization. (Figure 3,4). We observed that PCT was significantly increased in patients with postoperative infection after cardiac surgery and that it was more accurate parameter than CRP, WBC, ESR to predict the onset of postoperative infection and mediastinitis. In addition, PCT allows for early diagnosis. After CPB, activation of the inflammatory cascade may occur and this reaction demonstrates similarities to the reaction seen in sepsis. In this study, we monitored post-operative PCT levels after cardiac surgery and found that it was significantly elevated in patients who developed infectious complications and mediastinitis particularly. According to Meisner et al. an elevated PCT of more than 2 ng / ml can be observed after cardiopulmonary bypass in case of SIRS, and often in this case various infectious complications can be observed. Because CRP is a non-specific marker, its use in predicting the development of mediastinitis should always be combined with PCT testing.

Procalcitonin is an early and specific biological marker of infection in patients undergoing cardiac surgery with great predictive value if PCT – levels are above 2 ng / ml after the second postoperative day. Routine testing of procalcitonin may improve the treatment of these patients, allowing faster diagnosis and preventing the use of unnecessary antibiotics. Further studies are needed to confirm this hypothesis.

Despite the advanced surgical techniques, antibiotic prophylaxis, and strict patient care, the rate of development of deep wound infections seems to remain relatively constant over the years.

CONCLUSION

Open heart surgery is associated with higher risk of mediastinitis development. Improvements in surgical technique and specific biomarkers testing could significantly reduce the frequency of this life-threatening complication.

REFERENCES

- Abu-Omar Y, Kocher GJ, Bosco P, et al. (2017) European Association for Cardio-Thoracic Surgery expert consensus statement on the prevention and management of mediastinitis. *Eur J Cardiothorac Surg* ; 51:10.
- Baker AW, Lewis SS, Alexander BD, et al. (2017) Two-Phase Hospital-Associated Outbreak of Mycobacterium abscessus: Investigation and Mitigation. *Clin Infect Dis* ; 64:902.
- Calderwood MS, Kleinman K, Soumerai SB, et al. (2014) Impact of Medicare's payment policy on mediastinitis following coronary artery bypass graft surgery in US hospitals. *Infect Control Hosp Epidemiol* ; 35:144.
- Kohler P, Kuster SP, Bloemberg G, et al. (2015) Healthcare-associated prosthetic heart valve, aortic vascular graft, and disseminated Mycobacterium chimaera infections subsequent to open heart surgery. *Eur Heart J* ; 36:2745.
- Lazar HL, Salm TV, Engelman R, et al. (2016) Prevention and management of sternal wound infections. *J Thorac Cardiovasc Surg* ; 152:962.
- Perrault LP, Kirkwood KA, Chang HL, et al. (2018) A Prospective Multi-Institutional Cohort Study of Mediastinal Infections After Cardiac Operations. *Ann Thorac Surg* 2018; 105:461.
- Sax H, Bloemberg G, Hasse B, et al. (2015) Prolonged Outbreak of Mycobacterium chimaera Infection After Open-Chest Heart Surgery. *Clin Infect Dis* ; 61:67.
- Tarzia V, Carrozzini M, Bortolussi G, et al. (2014) Impact of vacuum-assisted closure therapy on outcomes of sternal wound dehiscence. *Interact Cardiovasc Thorac Surg* ; 19:70.
- Wingerden JJ, Ubbink DT, van der Horst CM, de Mol BA. (2014) Poststernotomy mediastinitis: a classification to initiate and evaluate reconstructive management based on evidence from a structured review. *J Cardiothorac Surg* 2014; 9:179.
- Vazhev, Z., Popova, V. (2017) Analysis of serum levels of opg at 24 and 48 hours in patients with acute coronary syndrome and inflammatory joint disease. *Osteoporosis International, Volume:29, Supplement:1 Pages:S214*