Factors Affecting the Incidence of Wound Infection in Patients after Valve Replacement

Thesis
Submitted for Partial Fulfillment of Master Degree in Cardiothoracic Sugary

By

Mostafa Mohamed Elsayed, MBBCH
Resident of Cardiothoracic surgery,
Faculty of Medicine, Minia University

Supervised By

Prof. Dr. Mohsen Mohamed Abdelkrem, MD.
Professor of Cardiothoracic Surgery,
Faculty of Medicine - Ain-shams University

Prof. Dr. Yasser Shaban Mubarak, MD.
Assistant Professor of Cardiothoracic Surgery
Faculty of Medicine - Minia University

Prof. Dr. Faisal Amr Mourad, MD.
Assistant Professor of Cardiothoracic Surgery,
Faculty of Medicine, Ain-shams University

Faculty of Medicine
Ain-shams University
2017

سورة البقرة الآية: ٣٢

Acknowledgment

First and foremost, I feel always indebted to ALLAH, the Most Kind and Most Merciful.

I'd like to express my respectful thanks and profound gratitude to Prof. Dr. Mohsen Mohamed Abdelkrem, Professor of Cardiothoracic Surgery, Faculty of Medicine - Ain-shams University for his keen guidance, kind supervision, valuable advice and continuous encouragement, which made possible the completion of this work.

I am also delighted to express my deepest gratitude and thanks to Prof. Dr. Yasser Shaban Mubarak, Assistant Professor of Cardiothoracic Surgery, Faculty of Medicine - Minia University, for his kind care, continuous supervision, valuable instructions, constant help and great assistance throughout this work.

I am deeply thankful to Prof. Dr. Faisal Amr Mourad, Assistant Professor of Cardiothoracic Surgery, Faculty of Medicine, Ain-shams University, for his great help, active participation and guidance.

I would like to express my hearty thanks to all my family for their support till this work was completed.

Last but not least my sincere thanks and appreciation to all patients participated in this study.

Mostafa Mohamed Elsayed

List of Contents

Title	Page No.
List of Tables	5
List of Figures	7
List of Abbreviations	9
Introduction	1
Aim of the Work	13
Review of Litertature	
▪ Anatomy of the Sternum	14
▪ Sternal Wound Infection Definitions & Classification	22
▪ Incidence & Risk Factors of Sternal Wound Infection	28
▪ Etiology & Microbiology	36
▪ Management of Sternal Wound Infection	41
Patients and Methods	61
Results	72
Discussion	88
Summary	103
Conclusion	105
References	107
Arabic Summary	

List of Tables

Table No.	Title	Page No.
Table (1):	Classification of deep sternal wound infection	25
Table (2):	Major clinical risk factors for SSWI	29
Table (3):	Summary of Factors Related to Wound Impairment in Obesity	30
Table (4):	Ormal Wound-healing Process	37
Table (5):	Microbiology of chronic infections (cases/controls) and subsequent deep sternal wound infection	40
Table (6):	Score to calculate DSWI predicted risk	46
Table (7):	Prevention of infection in cardiac surgery	49
Table (8):	Treatment algorithm	54
Table (9):	Preoperative demographic characteristics of all studied patients	72
Table (10):	Preoperative clinical risk factors in all studied patients	73
Table (11):	Preoperative echocardiographic results of all studied patients	74
Table (12):	Preoperative anti-septic measures in all studied patients	75
Table (13):	Operative and postoperative outcomes in all studied patients	76
Table (14):	Incidences of different types of sternal wound infection	77
Table (15):	Clinical presentation of 24 patients with sternal wound infections	79

List of Tables (Cont…)

Table No.	Title	Page No.
Table (16):	Microbiological results in 24 patients with sternal wound infection	80
Table (17):	Comparison of preoperative demographic and clinical characteristics in patients with sternal wound infection (SWI) versus control	82
Table (18):	Comparison of preoperative echocardiographic characteristics in patients with sternal wound infection (SWI) versus control	83
Table (19):	Comparison of preoperative anti-septic measures in patients with sternal wound infection versus control	84
Table (20):	Comparison of operative and postoperative outcomes in patients with sternal wound infection versus control	85
Table (21):	Significant perioperative risk factors associated for sternal wound infection using univariate regression analysis	86
Table (22):	Multivariate regression analysis of univariate significant perioperative risk factors associated for sternal wound infection	87

List of Figures

Fig. No.	Title	Page No.
Fig. (1):	Anterior view of sternum with clavicular and costal cartilage attachments	15
Fig. (2):	Bony surface landmarks on the anterior chest. Note the commonly used reference lines	16
Fig. (3):	Angiograms of the infant and adult internal thoracic arteries	17
Fig. (4):	Morphologic variants of the sternal blood supply	19
Fig. (5):	Schematic drawings of the sternal branches, representing the arcade pattern of the sternal blood supply	21
Fig. (6):	A DSWI with separation of the sternal halves and purulent drainage	23
Fig. (7):	The potential effects of diabetes on wound healing	31
Fig. (8):	Baseline score points accordingto BMI	42
Fig. (9):	Negative-pressure wound therapy consisting	55
Fig. (10):	PWT in use for DSWI, with sponge and wound drapes in place	57
Fig. (11):	The same patient as in figure (10) after two weeks of NPWT	58
Fig. (12):	Male patient 65 years after DVR with superficial sternal wound infection before treatment.	66
Fig. (13):	Male patient 65 years after DVR with superficial sternal wound infection after treatment.	67

List of Figures (Cont…)

Fig. No.	Title	Page No.
Fig. (14):	Male patient 55 years after DVR with mediastinitis.	69
Fig. (15):	Male patient 55 years after after ten days of NPWT.	70
Fig. (16):	Incidences of different types of sternal wound infection.	78
Fig. (17):	Clinical presentation of 24 patients with sternal wound infections.	79
Fig. (18):	Microbiological results in 24 patients with sternal wound infection.	81

List of Abbreviations

Abb.	Full term
NPWT	*Negative-Pressure Wound Therapy*
V.A.C	*Vacuum-Assisted Closure*
LOS	*Length of Stay*
CVA	*Cerebrovascular Accident*
CvT	*Conventional Treatment*
NRZ	*National Reference Center for Surveillance of Nosocomial Infections*
BQS	*Quality and Patient Safety*
DGTHG	*The German Society for Thoracic and Cardiovascular Surgery*
DGTHG	*German Society for thoracic and Cardiovascular Surgery*
GICS	*Gentamycin-Impregnated Collagen Sponge*
HbA1c	*Hemoglobin A1c*
TEE	*Trans Esophageal Echocardiography*
CT	*Computed Tomography*
MRSA	*Methicillin-Resistant Staphylococcus Aurous*
BMI	*Body Mass Index*
SSI	*Surgical Site Infection*
ITA	*Internal Thoracic or Mammary Artery*
CDC	*Centers for Disease Control and Prevention*
SCFs	*Sternocutaneous Fistulas*
DSWI	*Deep Sternal Wound Infection*

Abstract

Follow up the appropriate treatment for each type of SWI including repeated dressing and antibiotic with debridement for infected part in SSWI or VAC therapy and surgical debridement for DSWI.

The incidences of superficial sternal wound infection in 21 patients (19.44%) and deep sternal wound infection in 3 patients (2.77%). The causative organisms were *staph. aureus* in 33.33%, *staph. epidermis* in 16.66%, *staph pyogenes* in 25%, *streptococcus epidermis* in 4.16% and *E-coli* in 12.5%. There was no growth in 8.33%.

There are significant perioperative risk factors associated for sternal wound infection using regression analysis obesity, diabetes mellitus, elevated HA1c > 7%, history of hepatitis C, surgery for mitral valve disease, preoperative use of only one shower, no use of showering antiseptic, prolonged bypass time >120 min, blood loss > 500 ml in ICU, and prolonged mechanical ventilation > 12hours.

Keywords: *Deep Sternal Wound Infection -- Surgical Site Infection Centers for Disease Control and Prevention-Gentamycin-Impregnated Collagen Sponge*

INTRODUCTION

Despite optimized surgical technique and perioperative antibiotic prophylaxis, the incidence of sternal wound infection after cardiac surgery ranges from 1% to 5% ***(Gummert et al., 2002).*** The mortality for patients with deep sternal wound infection (DSWI) may be twice as high as those without. The development of sternal infection is associated not only with increased morbidity and death but also with prolonged hospital stay and higher costs ***(Braxton et al., 2008).*** Sternal wound infection is a devastating and fatal complication. They can be divided into superficial infections and deep infections, based on the depth of the infection in the wound. Early infections include both superficial infections, reaching the dermis and subcutaneous tissue, and deep sternal wound infections (DSWIs) that reach under the sternum and the anterior mediastinum. DSWI is also referred to as postoperative mediastinitis, which can present either early or as a late infection. Late infections include osteomyelitis, subcutaneous abscess, and sternocutaneous fistulas (SCFs) ***(Horan et al., 2008).*** According to Centers for Disease Control and Prevention (CDC) guidelines, the definition of a DSWI requires positive culture results of surgical sites or drainage from the mediastinal area or evidence of infection during surgical re-exploration or fever, sternal instability, and positive blood culture results ***(Mangram et al., 1999).*** Multiple modifiable and non-modifiable risk factors have been associated with DSWI.

Some of these factors are related to patient characteristics, whereas others are related to operative or perioperative management ***(Fowler et al., 2005)***. Patient factors include age, sex, obesity, diabetes mellitus or hyperglycemia during the perioperative period, smoking, staphylococcus aureus nasal carriage, skin infection anywhere on the body, chronic obstructive pulmonary disease, heart failure, kidney dysfunction, peripheral vascular disease, and emergent or urgent surgery ***(Cayci et al., 2008).*** Surgical risk factors include prolonged aortic cross-clamp time, cardiopulmonary bypass time or total surgical time, inadvertent Para median sternotomy, use of bone wax, extensive use of electro cauterization, procedures requiring prosthesis implant, use of intra-aortic balloon pump, postoperative bleeding, blood transfusions, re-exploration for bleeding, redo operation, prolonged mechanical ventilation, and prolonged ICU stay ***(Fakih et al., 2007).*** Strategies of treatment include surgical revision with primary closure, surgical revision with open dressing or closed irrigation, reconstruction with soft tissue flap, and application of vacuum ***(Steingrimsson et al., 2012).***

AIM OF THE WORK

The aim of this study is:

To detect how pre-, intra- and postoperative risk factors affect the incidence of sternal wound infection in patients after valve replacement.

Chapter 1
ANATOMY OF THE STERNUM

Bony Anatomy

The sternum is a sword-shaped flat bone about 15–17 cm long in the adult ***(Putz and Muller-Gerbi Benninghoff, 2003*)**. Its cranial part, the manubrium, connects to the corpus by a synchondrosis in 90% of adults; in the remaining 10% there is a bony fusion (synostosis). Its caudal part, the xiphoid process**.** The sternum is little convex ventrally emphasized by the individually variable sternal angle. The clavicle and the cartilage of the first rib articulate with the lateral margin of the manubrium while the cartilages of ribs from two through seven insert from the manubrium– corpus connection caudal on the lateral edge of the corpus, by true synovial joints. Sternocostal ligaments arranged criss-cross ventrally and dorsally attach the sternum with the rib cartilages, fusing with both their periosteal and perichondrium, respectively, thus forming a firm membrane especially on the ventral side. The thickest part of the sternum is cortical bone in the manubrium but relatively thin in the other parts.

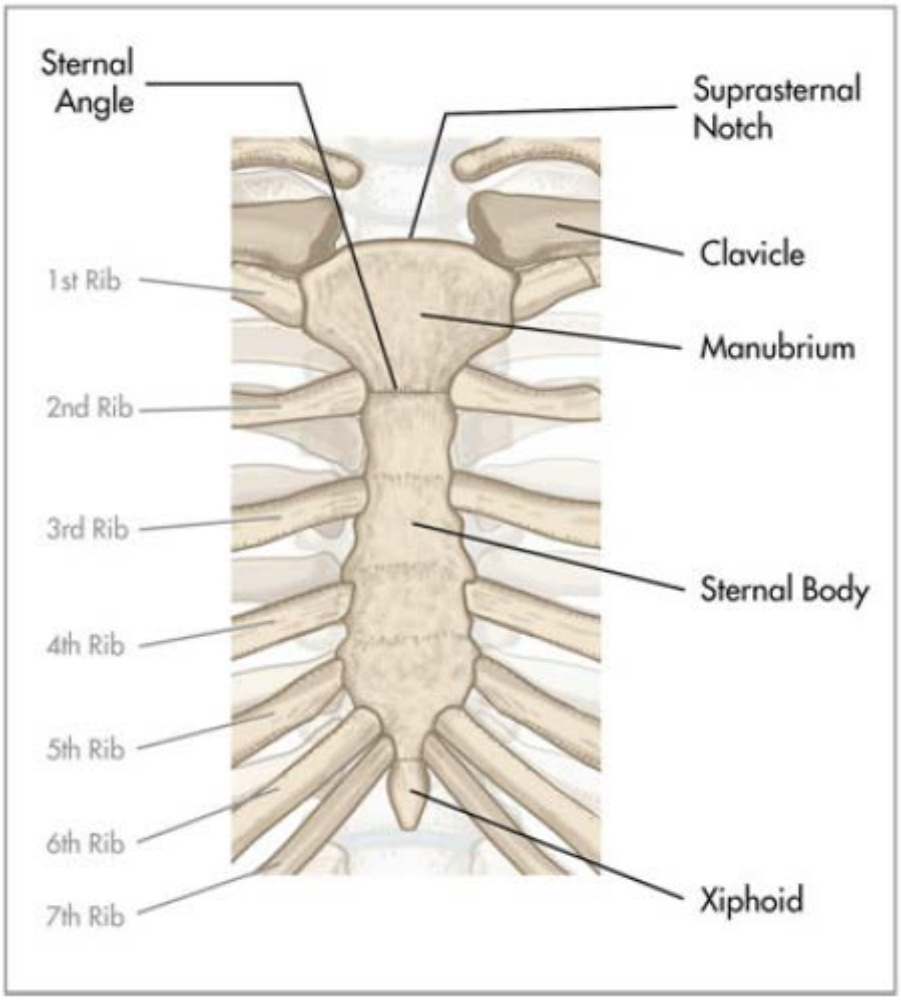

Fig. (1): Anterior view of sternum with clavicular and costal cartilage attachments ***(Raff and Hirose, 2016).***

Relationship to Muscles

Anteriorly, the pectoralis major sternum attach to the sternum, dorsally the sternum attach to the transversus thoracic. The xiphoid process provides attachment to the aponeuroses of the oblique and transverse abdominal muscles and the sheath of the rectus abdominal formed by them; the linea Alba is attached