

The history of the management of sternal osteomyelitis and mediastinitis – from Hippocrates until today

Management der Sternumosteomyelitis/Mediastinitis: ein historischer Überblick – Hippokrates bis heute

Abstract

Even during the time of Hippocrates, Galen and their colleagues recognized mediastinal affections. However, they were not considered with the surgical treatment. First progress in the treatment options of this severe disease, still denoted as 'terra incognita', over to today's gold standard are pictured.

The mediastinitis-registry which was founded by the German Society for Thoracic and Cardiovascular Surgery (DGTHG) in 2011 and the recent establishment of the study group to adopt a guideline 'diagnosis and therapy of postoperative mediastinitis/sternal osteomyelitis following cardiac surgery' are attempts to a standardization of the treatment. Substantial advancement in the treatment of postoperative mediastinitis could be achieved in the past. The mortality dropped as low as less than 10%.

With these implementations more benefit for the patients' outcome can be expected.

Zusammenfassung

Aus der Schaffensperiode von Hippokrates, Galen und Kollegen ist das Wissen um Mediastinalerkrankungen überliefert. Chirurgische Therapiemöglichkeiten gab es zu der Zeit noch keine. Die ersten Schritte in der Behandlung dieses schwierigen Krankheitsbildes, damals noch als ‚Terra Incognita‘ bezeichnet, bis zum heute angewendeten Goldstandard werden dargestellt.

Im Ausblick wird auf ein bundesweites Mediastinitisregister, initiiert von der Deutschen Gesellschaft für Thorax-, Herz- und Gefäßchirurgie (DGTHG) 2011, verwiesen, ebenso wie auf die derzeitige Erstellung einer Leitlinie zur standardisierten Behandlung der postoperativen Mediastinitis/Osteomyelitis. In der Vergangenheit konnten substantielle Verbesserungen in der Behandlung dieser Patienten erreicht werden. Die Letalität konnte auf unter 10% gesenkt werden. Durch diese Maßnahmen wird ein weiterer Benefit für die betroffenen Patienten erwartet.

Introduction

Even during the time of Hippocrates, Galen and their colleagues recognized mediastinal affections. However, they were not considered with the surgical treatment. In the 'Practica' of Roger written about 1170 and revised by Roland in 1230, it was written about a trepanation of the sternum. "If the shaft of an arrow had penetrated the bone". The way this was quoted suggests that it was a known injury [1].

In 'The Discourses of the whole Art of Chyrurgerie' which was written by Peter Lowe and published in 1597, the method of collecting mediastinal debris was described. He wrote: "...for the cure thereof Columbus counsoleth

to trepan the sternum but I rather in that case approve of the cauter potential as counsoleth Arnaldusi making a good eschare, hold it long open. This care is rare and seldom practised, yet after this method I did cure one John Buchan." [2]

In 1718 Heister advised trepanation of the sternum, if the prudent surgeon or physician is satisfied that "...an abscess is formed in this part", i.e., the mediastinum [3]. In 1774 Petit in his 'Traité de maladies chirurgicales' gives details of a case in which he drained a mediastinal abscess following an injury to the sternum [4].

In 1750 Sharp [5] as in 1771 Aurrant [6] advised trepanation of the sternum to evacuate mediastinal collections.

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In 1799 Chopart and Desault mentioned, “trepanation is necessary to give issue to the pus (contained within the mediastinum)... But if the infection extends to the sides or above the sternum one must incise the soft parts over the intercostal spaces or at the base of the neck as well as trepan the sternum over the site of the greatest pain.” [7]

During 1793–1794 Lorenzo Nannoni advised trepanation of the sternum for caries of that bone [8]. ([1]–[8] cited from [9]).

First progress, but still ‘terra incognita’

Now we are entering the 19th century with an established procedure for mediastinal affections. Nevertheless, in that time the mediastinum still remains a ‘terra incognita’. In 1888 Rouilles published a paper with the topic of sternal resections due to infection and tumors. He presented pretty good results: 115 cases, 42 complete and 45 incomplete healings, 28 cases of death, in hospital lethality 32.2% [10].

At the beginning of cardiac surgery the heart was exposed by an anterolateral or posterolateral thoracotomy. Becoming more and more complex, the incisions often were extended across the midline to the contralateral side, so called clamshell incision. This access was time-consuming and was associated with a great blood loss and pain for the patients [11].

Midline sternotomy was first described by Milton in 1887. It was reintroduced by Julian and colleagues in the mid-1950s. It offers a more extended exposure of the thoracic cavity. It is a quick and easy done performance, causes less pain, little blood loss and hardly any functional impairment [12].

In 1953 Shoemaker was the first to perform midline sternotomy in an elective cardiac operation. Today this access has become the common one in open heart surgery and is performed about 100,000 times per year in Germany. Despite all advantages and years of experience this access offers, serious complications may occur with an incidence rate of 1–4%, the mortality rate up to 50% [13].

What is the state of the affairs concerning treatment options nowadays since cardiac surgery is introduced?

Treatment procedures in chronological order

In the early time of cardiac surgery surgeons managed to treat mediastinitis/sternal osteomyelitis with open technique. This comprehends reopening of the sternum, surgical debridement, changing dressings with moist compresses and waiting for spontaneous wound closure by granulation and epithelization. It required months to achieve a healed wound. Because of the high failure and mortality rate up to 50% due to sepsis, erosion bleeding

or direct injuries of the heart caused by sternal or osseous fragments, these methods were dropped [11], [14].

An important step in the treatment of sternal infection due to sternotomy was the introduction of continuous saline, antibiotic and polyvidone irrigation by Bryant and colleagues in 1969 [15], [16]. This also included reopening of the sternum, debridement of the whole area and removal of synthetic materials. An extensive irrigation was performed. Two irrigations and two drainage catheters were positioned retrosternally and the sternum was primarily closed as well as the soft tissue layers [11]. This procedure was followed by intermittent or continuous irrigation, until three pathogen-free effluates were obtained from the effluat. If the bacterial growth could not be determined, the irrigation therapy was terminated after 4 weeks at the latest. The advantages of this technique are immediate sternal stability and soft tissue closure. It is limited in severe osteomyelitis and soft tissue infection. The disadvantages of the method are the creation of death space, risk of catheter erosion associated complications and the possibility of systemic absorption of the irrigation fluid. The morbidity and mortality rate up to 20% and more is still high [14], [16], [17].

In those patients wherein the irrigation technique did not succeed and failed, another approach had to be established. In 1975 Jurkiewicz and colleagues began to treat those patients with radical surgical debridement followed by closure using muscle or omental flaps. The mortality dropped dramatically to <10% [17]. In 1976 Lee and colleagues described the use of omentum to close an open mediastinal defect successfully for the first time [18].

Today’s gold standard

It is an unalterable objective of a successful surgical treatment to perform a radical debridement of the infected area. This includes complete excision of all non-vital, infected and necrotic tissue components. Foreign materials such as wire cerclages or pacer cables for example, have to be removed. An ongoing infection maintains necrosis, which then in turn leads to tissue decline. Subsequent reconstruction procedures are then doomed to failure [13].

The reconstruction of the anterior chest wall may be achieved by local pedicled or free flaps. The surgical procedures used most often are listed below.

Pedicled flaps:

- Uni- or bilateral pectoralis major flaps, with or without desinervation of the insertion on the humerus
- Pectoralis major turn over flap
- Latissimus dorsi flap
- Greater omentum flap
- Rectus abdominis flap

If the first choice muscles mentioned above failed to succeed, free flap-plasty might be indicated. First choice

of recipient vessels are the internal mammarian, thoraco-dorsal and the thoracoacromial vessels. In selected cases if those vessels are already used or damaged, AV-loops might be unalterable. They are created via cephalic vein/A. axillaris or A. thoracodorsalis.

Optionally most used free flap is the tensor fascia lata (TFL) [19].

The next landmark in the treatment of mediastinitis/sternal osteomyelitis was the introduction of the vacuum-assisted closure therapy (VAC) by Argenta and Morykwas in 1997, first used in the field of surgery of the limbs [20].

VAC for treatment of postoperative mediastinitis was first described by Obdeijin and colleagues in 1999 [11].

It is a secondary healing system based on the application of a local vacuum of up to 120 mmHg in the area of the wound. It comprises an open-cell polyurethane sponge, which is applied airtight with a foil to the wound to close it up. The sponge includes a drainage discharge tube and a fluid reservoir with the vacuum device. Acute, sub-acute and chronic wounds are characterized by a more or less peripheral edema, which might impede lymph drainage and microcirculation. The vacuum system removes fluids which reduces the pressure in the local tissue. This leads to a dilatation of the capillaries and improves the blood flow followed by a proliferation of granulation tissue and angiogenesis. The bacterial count drops due to the continuous removal of secretion and debris [13], [14], [20]. Sjögren recommends this procedure as a self-contained treatment with direct closure of the sternum and the soft tissue layers [21], most surgeons use it as a bridging procedure as short as possible until the final reconstruction by muscle flaps [11], [19]. There is currently no general consensus regarding appropriate postoperative surgical therapy for mediastinitis/sternal osteomyelitis [22]. The search of a standardized treatment for postoperative mediastinitis/sternal osteomyelitis is still ongoing [23]. A paradigm shift in the therapy is initiating. Away from open or irrigation technique to combination procedures on an individual basis.

Outlook

Mediastinitis-Registry: The DGTHG's founding of the mediastinitis register on 15th of June 2011 started as a nationwide project to improve patient care in Germany. The aim is to track the developing of these disease occurrences in Germany. With this institution clinicians have the opportunity to receive statistical analyses of risk factors, treatments and outcomes of an increased number of patients. It is the register's intent to develop and provide differentiated and improved treatment options. Participation, however, is optional [24].

Another attempt to standardization is the recent establishment of the study group to adopt a guideline 'diagnosis and therapy of postoperative mediastinitis/osteomyelitis following cardiac surgery' [25].

Substantial advancement in the treatment of postoperative mediastinitis/sternal osteomyelitis could be achieved in the past. The mortality dropped as low as less than 10% [13].

With the implementation of a guideline to standardize the treatment, even more benefit for the patients' outcome can be expected.

Notes

Competing interests

The authors declare that they have no competing interests.

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