STERNAL WOUND RECONSTRUCTION WITH PORCINE ACELLULAR DERMAL MATRIX (STRATTICE) FOR POSTSTERNOTOMY MEDIASTINITIS

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Summary. Sternal reconstruction could be a complex and challenging procedure. Common indications are defects after heart surgery, infections, tumour ablation, radiation necrosis, congenital deformities and trauma. Aloplastic materials are often used for sternal stabilization and regional flaps are applied to provide well vascularized soft tissue coverage. Although numerous materials are available, acellular dermal matrice have some advantage that could be of benefit in the repair of the anterior mediastinum and chest wall. We present a case of a 72-year-old male patient whit mediastinitis and sternal dehiscence after triple-vessel coronary artery bypass grafting and failure of the initial chest wall closure. After conservative treatment and VAC-therapy, titanium plates were used to restore the sternal continuity. Porcine acellular dermal matrix (Strattice™ Tissue Matrix) was applied for wrapping the fixation plates and reinforcing the pectoralis muscle flaps used for soft tissue coverage. Due to its ability to become incorporated and vascularized, to resist wound infections and to provide stability, Strattice seems to be a promising, although probably not enough efficient alternative of the synthetic materials. To our knowledge, this is the first report in the Bulgarian scientific literature of sternal reconstruction by using a porcine acellular dermal matrix (Strattice).

Key words: *sternal reconstruction, mediastinitis, porcine acellular dermal matrix, Strattice*

INTRODUCTION

Mediastinitis with sternal dehiscence is one of the most dreaded complications after median sternotomy, resulting in significant morbidity and mortality. The reported incidence of mediastinitis after open

heart surgery ranges from 0.3% to 5% in the literature [1] and carries an in-hospital mortality rate of 8% to 25% [2]. Poststernotomy mediastinitis, also known as deep sternal wound infections, also leads to a dramatic increase in the length of hospital stay and overall health care costs. In such cases, mediastinal reconstructions could be challenging and often require a multidisciplinary approach including a plastic surgeon.

The treatment of sternal dehiscence and mediastinitis has evolved over the years with major improvements in postoperative care and advancements of operative techniques. In 1963, Shumacker and Mandelbaum [3] described the first method of treating mediastinitis involving surgical debridement followed by primary closure over irrigation catheters [4]. Unfortunately, this method yielded unsatisfactory results with high morbidity and mortality rates, leading to the use of muscle flaps for sternal reconstruction in 1980 [5]. More recently, vacuum-assisted closure (VAC) dressings have been used in the management of sternal wound and have allowed a good long-term result to be achieved [6-8]. Lastly, novel sternal closure devices have also been used in the management of selected cases [9, 10].

Resection and musculocutaneous flap is a good therapeutic option for high-risk patients, providing a safe, effective control of the infection and acceptable results in terms of pain control and quality of life [11]. Soft tissue flaps like muscle flaps and omental flaps are generally needed to provide well vascularized tissue when alloplastic materials are used for sternal stabilization. Regarding the muscle flaps, pectoralis major, rectus abdominis and latissimus dorsi are most commonly used, with pectoralis major flap being the first-choice procedure because of its easy access and less morbidity [12, 13].

Despite all the improvements, there is no singular strategy for the management of mediastinitis with sternal dehiscence after open heart surgery. Although there are numerous studies reported in the literature, there does not seem to be a consensus regarding either the method of debridement of the sternal wounds, or the technique for definitive closure.

The use of porcine acellular dermal matrix (Strattice™ Tissue Matrix) has been well described and significantly increased during the last decade in the field of reconstructive surgery. It is recommended for use in soft-tissue repair because of its resistance to infection, lack of adhesion formation and the advantage of becoming vascularized and incorporated autologously. Considering all these facts, Strattice seems to be a promising alternative to synthetic materials in some circumstances. At the present time it is basically applied in breast reconstructive and aesthetic surgery [14-16].

We report a case of recently attended by our team patient who presented with mediastinitis and sternal dehiscence after heart surgery and two episodes of heart tamponade. We have successfully applied a porcine acellular dermal matrix as a main component of the complex sternal reconstruction in this patient.

CASE REPORT

A 72-year-old man diagnosed of chronic ischemic cardiopathology underwent triple-vessel coronary artery bypass grafting. On the eighth postoperative day he developed a cardiac tamponade and another one 38 hours later. Two sternotomies were applied in 48 hours, respectively. These events were associated with renal failure and pneumonia caused by Serratia with respiratory distress. A sternal fixation with steel cerclage wires and bilateral pectoralis major flaps was performed by cardiac surgery team after the second sternotomy because of the cardiac tamponade. However, after this procedure a dehiscence occurred. Microbiological study demonstrated S. epidermidis mediastinitis. Six weeks later the plastic surgeons of our team were called to evaluate the patient for possible chest wall reconstruction. A sternum divided in the midline and a wound with purulent discharge, necrotic tissue and bony instability were presented. First we established a treatment comprising aggressive necrotic tissue debridements, VAC-therapy and intravenous antibiotherapy for 4 weeks. When 3 consecutive cultures of the sternal wound resulted negative, a surgical approach was considered in order to perform a sternal fixation, wound closure and soft tissue coverage. We first used a titanium plate to make the osteosynthesis and then we placed a Strattice over it (Fig. 1). Then we used the pectoralis muscle flaps to overlap and protect the acellular dermal matrix. After ten days, another sternal dehiscense was presented, but the wound cultures were negative. We established an irrigation treatment with saline serum for 3 weeks and a new osteosynthesis was made with wires and titanium plates. Interestingly, we observed that there was a granulation tissue growing in the lateral aspects of the Strattice matrix, and fibrous tissue was presented between the borders of the sternal bone (Fig. 2), giving it sufficient bony stability. Biopsies by punch were taken for histological study in order to verify the dermal matrix integration (Fig. 3). For the repair procedure at that time we used a new titanium plate only. First we placed a patch of Strattice under the plate and then we wrapped it (Fig. 4). Over this field we placed the remaining part of the pectoralis major flaps and a second dermal matrix was sutured over the union of both flaps in order to reinforce the muscle tissue. Postoperative evaluation showed a correct wound healing without any sign of wound dehiscence or infection. No complications were registered in the postoperative period and after 23 days of observation the patient was satisfactory discharged from the hospital (Figs. 5a and 5b).

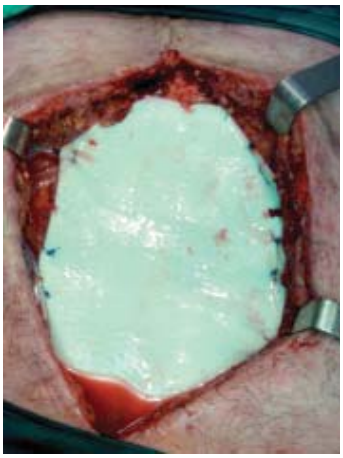


Fig. 1. Strattice placed over the osteosynthesis of the sternal bone made with titanium plate and wires



Fig. 2. Granulation tissue growing in the lateral aspects of the first Strattice matrix and exposition of a considerable part of the titanium plate. Fibrous tissue was presented between the borders of the sternal bone giving sufficient bony stability

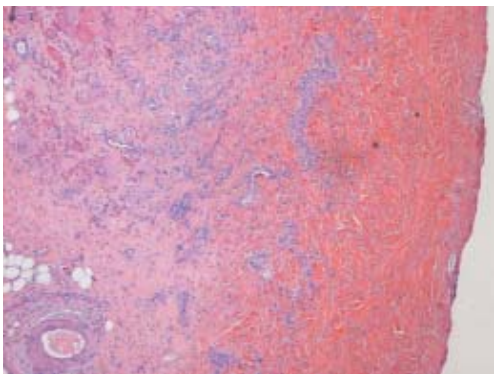


Fig. 3. HE staining: a fibroblastic reaction with focal tissue integration of the matrix



Fig. 4. New osteosynthesis with a titanium plate made over a patch of Strattice



Fig. 5a. Sternal wound with purulent discharge, necrotic tissue and bony instability before the first placement of Strattice



Fig. 5b. Six months after the second reconstructive procedure

DISCUSSION

Poststernotomy mediastinitis, also commonly called deep sternal wound infection, is one of the most feared complications in patients undergoing cardiac surgery. In patients with deep sternal wound infection a preservation of the sternum at the time of reconstruction should be the principal aim of surgical treatment. On the other hand, aggressive surgical treatment by debridement is crucial for the success of the healing process. Chest wall reconstruction following extensive resection is greatly facilitated by the use of vascularised flaps and plastic surgeons are often asked to assist with coverage of large chest wall defects. However, in addition to soft tissue coverage, we need to address the requirement for skeletal support.

Conventional forms of treatment usually involve surgical revision with open dressings or closed irrigation and reconstruction with vascularized soft tissue flaps such as omentum, pectoralis muscle or even rectus abdominis flaps. Vaccum-assisted closure therapy acts as a link between radical debridement and definitive plastic coverage [8]. The type of flap is individually chosen based on location of the defect and availability of certain vascular axis [13].

Since the sternal instability is a very serious complication after median sternotomy, an important complement to the traditional reconstructive procedures in mediastinal reconstruction are the alloplastic materials. Biomechanical studies have suggested superiority of rigid plate fixation over wire cerclage for sternal fixation and it was published that patients who benefited from sternal closure with rigid plate fixation showed a significant decrease in the incidence of post-operative mediastinitis when compared to similar population of patients whose sternum were closed with wire [17].

Other types of alloplastic materials can provide stability of the chest wall, but unfortunately there are not many publications about their use in mediastinal reconstruction. Polypropylene mesh has showed good results in chest wall reconstruction [18]. In nine consecutive patients chest wall repair due to either secondary incisional herniation or malignant disease with chest wall infiltration was performed with a Peri-Guard Repair Patch (Synovis, St. Paul, MN, USA). At follow-up (4 ± 2 months), quality of life, signs of re-herniation and incorporation of mesh (radiograph, blood samples and ultrasound) showed a high rate of success in reconstruction [19].

Chest wall reconstruction was done also in ten patients by using human acellular dermis [20]. Indications included thoracic tumor, Clagett procedure modification for postpneumonectomy empyema, resection of chest wall osteomyelitis, and pneumonectomy for multiple aspergillomata. Complications occurred in 4 patients and included respiratory failure, pneumonia, and wound seromas. All wounds healed without need to remove or revise the human acellular dermis, and sound chest wall closure was achieved in every case. The authors concluded that human acellular dermis is an effective but expensive alternative to synthetic mesh in reconstruction of chest wall and diaphragmatic defects. It is particularly attractive for use under conditions of potential or overt contamination.

In a rabbit model a comparison in reconstruction of lateral thorax defect between Goretex TM and AllodermTM (human cadaveric acellular dermal matrix) showed that the tensile strength of the Alloderm fascia was significantly greater than that of the polytetrafluorethylene-fascia [21]. Explanted Alloderm sections demonstrated cellular infiltration throughout the majority of the Alloderm grafts. These grafts were incorporated into the surrounding tissue at all interfaces with blood vessels penetration. It was correlated with CD 31 immunostaining.

In 2011 Huston et al [22] published a case of chest wall reconstruction with porcine acellular dermal matrix (Strattice) and a latissimus dorsi myocutaneous flap. StratticTM tissue reconstructive matrix (LifeCell, Branchburg, NJ, USA) is a porcine acellular dermal matrix that has been used in many plastic surgery procedures. It is used for soft-tissue repair including tissue expander/implant breast reconstruction, allowing control of the inframammary fold, as well as adding an extra layer of protection over the lower pole of the expander when it is used as an extension of the pectoralis major muscle pocket as in breast reconstruction [14, 23], for abdominal wall reinforcement [24], etc. The biopsy of the Strattic demonstrated mild fibroblastic reaction with focal tissue integration of the matrix. Capillarie ingrowth in the matrix was clearly evident. However, this was a focal phenomenon [25]. Another laboratory studies using a primate animal model have shown host cells colonization and functional neoangiogenesis into implanted acellular dermal matrix of human cadaveric origin (AlloDerm) as early as one month after the implantation procedure [26].

In our patient, porcine acellular dermal matrix was perfectly incorporated into the sternal bone and the anterior aspects of the chest wall. The presence of granulation tissue around the external limits of the patch was a sign of good integration of the matrix into the anterior chest wall. Interestingly, the matrix had promoted a sufficient healing of the sternal bone despite the dehiscence presented after the first operation performed by our team. On the other hand, cultures were negative after the operation and that contributed to good stability of the sternum. For that reason during the second reconstructive procedure performed by us only one plate was used in order to reinforce the sternum; the rest of pectoralis major muscles were applied just for soft tissue coverage.

CONCLUSION

To our knowledge, this is the first reported clinical reconstruction of the mediastinum performed with porcine acellular dermal matrix in a non-immunosuppressed patient. The porcine acellular dermal matrix seems to be an effective method for sternal reconstruction after mediastinitis and sternal dehiscence but further investigations are needed.

REFERENCES

1. Oakley, R. M. et J. E. Wright. Postoperative mediastinitis: Classification and Management. – Ann. Thorac. Surg., **61**, 1996, 1030-1036.
2. Sjögren, J. et al. Poststernotomy mediastinitis: a review of conventional surgical treatments, vacuum-assisted closure therapy and presentation of the Lund University Hospital mediastinitis algorithm. – Eur. J. Cardiothorac. Surg., **30**, 2006, № 6, 898-905.
3. Shumacker, H. B. Jr. et I. Mandelbaum. Continuous antibiotic irrigation in the treatment of infection. – Arch. Surg., **86**, 1963, 384-387.
4. Bryant, L. R., F. C. Spencer et J. K. Trinkle. Treatment of median sternotomy infection by mediastinal irrigation with an antibiotic solution. – Ann. Surg., **169**, 1969, 914-920.
5. Jurkiewicz, M. J. et al. Infected median sternotomy wound: Successful treatment with muscle flaps. – Ann. Surg., **191**, 1980, № 6, 738-744.
6. Obdeijn, M. C. et al. Vacuum-assisted closure in the treatment of poststernotomy mediastinitis. – Ann. Thorac. Surg., **68**, 1999, 2358-2360.
7. Dickie, S. R., A. H. Dorarshar et D. H. Song. Definitive closure of the infected median sternotomy wound: A treatment algorithm utilizing vacuum-assisted closure followed by rigid plate fixation. – Ann. Plast. Surg., **56**, 2006, 680-685.
8. Agarwal, J. P. et al. Vacuum-assisted closure for sternal wounds: a first-line therapeutic management approach. – Plast. Reconstr. Surg., 116, 2005, № 4, 1035-1040; discussion 1041-1043.
9. Levin, L. S. et al. An innovative approach for sternal closure. – Ann. Thorac. Surg., **89**, 2010, 1995-1999.
10. Ceresa, F., G. Casablanca et F. Patane`. Complicated sternal dehiscence treated with the Strasbourg thoracic osteosyntheses system (STRATOS) and the transposition of greater omentum: a case report. – J. Cardiothorac. Surg., **5**, 2010, 53.
11. Immer, F. F. et al. Deep sternal wound infection after cardiac surgery: modality of treatment and outcome. – Ann. Thorac. Surg., **80**, 2005, № 3, 957-961.
12. López-Monjardin, H. et al. Omentum flap versus pectoralis major flap in the treatment of mediastinitis. – Plast. Reconstr. Surg., **101**, 1998, № 6, 1481-1485.
13. Greig, A. V. et al. Choice of flap for the management of deep sternal wound infection- an anatomical classification. – J. Plast. Reconstr. Aesthet. Surg., **60**, 2007, № 4, 372-378.
14. Spear, S. L. et al. Acellular dermis-assisted breast reconstruction. – Aesthetic. Plast. Surg., **32**, 2008, 418-425.
15. Jansen, L. A. et S. A. Macadam. The use of AlloDerm in postmastectomy alloplastic breast reconstruction: Part I. A systematic review. – Plast. Reconstr. Surg., **127**, 2011, 2232-2244.
16. Maxwell, G. P. et A. Gabriel. Revisionary breast surgery with acellular dermal matrices. – Aesthet. Surg. J., **31**, 2011, 700-710.
17. Song, D. H. et al. Primary sternal plating in high-risk patients prevents mediastinitis. – Eur. J. Cardiothorac. Surg., **23**, 2003, № 6, 943-949.
18. Hemeed, A. et al. Reconstruction of complex chest wall defects by using polypropylene mesh and a pedicled latissimus dorsi flap: a 6-year experience. – J. Plast. Reconstr. Aesthet. Surg., **61**, 2008, № 6, 628-635.
19. Weigmann, B. et al. Biological materials in chest wall reconstruction: initial experience with the Peri-Guard Repair Patch. – Eur. J. Cardiothorac. Surg., **37**, 2010, № 3, 602-605.
20. Ge, P. S. et al. The use of human acellular dermal matrix for chest wall reconstruction. – Ann. Thorac. Surg., **90**, 2010, № 6, 1799-1804.
21. Holton, L. H. 3rd et al. Comparison of Acellular Dermal Matrix and Synthetic Mesh for Lateral Chest Wall Reconstruction in a Rabbit Model. – Plast. Reconstr. Surg., **119**, 2007, № 4, 1238-1246.

22. Huston, T. L., B. Taback et C. H. Rohde. Chest wall reconstruction with acellular dermal matrix (strattice) and a latissimus myocutaneous flap. – Am. Surg., **77**, 2011, № 6, e115-116.
23. Sbitany, H. et al. Acellular dermis-assisted prosthetic breast reconstruction versus complete submuscular coverage: a head-to-head comparison and outcomes. – Plast. Reconstr. Surg., **124**, 2009, № 6, 1734-1740; discussion 1741-1742.
24. Cicilioni, O. Jr. et al. Initial experience with the use of porcine dermal matrix (strattice) for abdominal wall reinforcement after transverse rectus abdominis myocutaneous flap breast reconstruction. – Ann. Plast. Surg., **68**, 2012, № 3, 265-270.
25. Katerinaki, E., U. Zanetto et G. D. Sterne. Histological appearance of strattice tissue matrix used in breast reconstruction. – J. Plast. Reconstr. Aesthet. Surg., **63**, 2010, № 12, e840-841.
26. Xu, H. et al. Host response to human acellular dermal matrix transplantation in a primate model of abdominal wall repair. – Tissue Eng. Part A, **14**, 2008, № 12, 2009-2019.

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