ANTERIOR CHEST WALL RECONSTRUCTION WITH HETEROLOGOUS ACCELLULAR DERMAL MATRIX- CLINICAL CASE REPORT

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ABSTRACT
Anterior chest wall reconstruction is a challenging initiative, particularly after deep sternal infection. The location and the size of the defect play a major role when selecting the method of repair, while good aesthetic and functional outcome remain a primary goal. Alopastic materials are often used for sternal stabilization and loco-regional flaps are applied to provide well vascularized soft tissue coverage. Although numerous products are available today, acellular dermal matrices have some advantage that could be of benefit in the repair of the anterior mediastinum and chest wall. In this clinical report, we present a case of a patient with poststernotomy mediastinitis and wound dehiscence after cardiovascular surgery and failure of the initial chest wall repair. After conservative treatment and Negative Pressure Wound Therapy, titanium plates were used to restore the sternal continuity. Acellular dermal matrix of porcine origin was applied for improving and reinforcing the fixation plates and soft tissue repair accomplished by local muscle flaps. Due to its ability to become incorporated and vascularized, to resist wound infections and to provide stability, acellular dermal matrix seems to be a promising although probably not enough efficient alternative of the synthetic materials in sternal reconstruction and anterior chest wall repair.

Key words: porcine acellular dermal matrix, Strattice, anterior chest wall, mediastinitis, sternal reconstruction.

INTRODUCTION
Mediastinitis with sternal dehiscence is one of the most dreaded complications after median sternotomy, resulting in significant morbidity and
Ключови думи: свински ацелуларен дермален матрикс, Strattice, предна грудна стена, медиастинит, реконструкция на стернума.

УВОД
Медиастинитът с дехисценция на грудната кост е едно от най-опасните усложнения след срединна стернотомия с висок морбидитет и смъртност. Честотата на медиастинитата след конвенционална сърдечна операция варира в диапазона от 0.3 % до 5% (1). Болнична смъртност при това усложнение е от 8% до 25 %, като също така води до рязко увеличение на продължителността на болничния престой и разходите за лечение (2). Реконструкцията на медиастинума е предизвикателство и често налага мултидисциплинарен подход с участието на пластичен хирург.

Съвършениятата по отношение на лечението на медиастинита и стерналната дехисценция еволюират значително през последните години. Особен напредък се отбелязва в оперативните техники и следоперативните гръжи. През 1963 г. Shumacker и Mandelbaum (3) разработват първия метод за лечение на медиастинит, включващ хирургичен дебриджан (екскизионно почистване), последван от директно затваряне над иригационни катетри. Въпреки първоначалния ентусиазъм, този метод дава незадоволителни резултати по отношение на патологичната поразеност и смъртността, което се оказва важна предпоставка за въвеждането на мускулните ламба в реконструкцията на стернума през 1980 (4). По-късно вакуум-асистираната терапия (т. нар. VAC-терапия) започва да се използват в лечението на стерналните дефекти и позволява постигането на добри резултати в дългосрочен план (5,6). В последните години биват въведени нови устройства за възстановяване на стернални дефекти, които намират приложение при определени случаи (7).

Резекцията на грудната кост и мускуло-кутаниите ламба са добър подход при високо-рискови пациенти. Той осигурява ефективен контрол на инфекцията и приемливи резултати по отношение на контрола на болката и качеството на живот (8). Мекотъканите ламби, като мускулните и оментума, осигуряват добре кръвообращения меха тъкан за покритие, когато за стабилизация на грудната кост се използват различни алпластични материали. Мекотъкано ламбо на първи избор е големият пекторален мускул, поради лесния достъп и по-ниския морбидитет.

Mortality. The reported incidence of mediastinitis after open heart surgery ranges from 0.3% to 5% in the literature (1). It carries an in-hospital mortality rate of 8% to 25% and leads to a dramatic increase in length of hospital stay and overall health care costs (2). 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) devised the first method of treating mediastinitis involving surgical debridement followed by primary closure over irrigation catheters. However, this method yielded unsatisfactory results with high morbidity and mortality rates, leading to the use of muscle flaps for sternal reconstruction in the 1980 (4). More recently, vacuum-assisted closure (VAC) dressings have been used in the management of sternal wound and have allowed good long-term results to be achieved (5,6). Lastly, novel sternal closure devices have also been used in the management of selected cases (7).

Sternal resection and musculocutaneous flaps are a good approach for high-risk patients. It provides an effective control of the infection and acceptable results in terms of pain control and quality of life (8). 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 being the pectoralis major flap the first-choice procedure because of its easy access and less morbidity (9).

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, to date there is not a consensus regarding the method of sternal wounds debridement and the technique for definitive closure.

The use of porcine acellular dermal matrix (ADM) has been well described and significantly increases during the last decade in the field of reconstructive surgery (10-12). 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™ Tissue Matrix seems to be a promising alternative to synthetic materials in some circumstances. Nowadays it is basically applied in the breast surgery and for abdominal wall repair (Table 1) (13,14).
We report a clinical case where a porcine ADM has been successfully applied as a main component of a complex sternal reconstruction.

Case report

A 72-year-old man diagnosed of chronic ischemia 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 to renal failure and pneumonia by Serratia marcescens with respiratory distress. A sternal fixation with steel cerclage wires and bilateral pectoralis major flaps were performed by cardiac surgeons after the last sternotomy. This procedure resulted unable to solve the chart and dehiscence occurred. Microbiological study demonstrated Staphylococcus epidermidis infection. Six weeks later the plastic surgeons of our team were called to evaluate the patient for possible reconstruction.

We found a wound with purulent secretion and necrotic tissue; a divided sternum in the midline with bony instability was presented. We established a treatment comprising aggressive necrotic tissue debriments, VAC-therapy and intravenous antibiotic therapy for four weeks. When three consecutive cultures of the sternal wound resulted negative, a reconstructive approach was considered to perform a sternal fixation, wound closure and soft tissue coverage.

First, a titanium plate was applied to make the osteosynthesis and than a Strattice patch was placed above (Fig. 1). Then we used the pectoralis muscle flaps to overlap and protect the ADM. 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 performed. We observed that there was a granulation tissue growing in the lateral aspects of the ADM, and fibrous tissue was presented between the medial borders of the sternum bone giving it bony stability at certain degree. Biopsies by punch were taken for histological study in order to verify the ADM integration (Fig. 2). For the reconstruction aim at that time a new titanium plate was applied with a patch of Strattice wrapped around it (Fig. 3). The remaining parts of the pectoralis major flaps were placed above. Then a second ADM was sutured over the union of both flaps in order to reinforce the soft tissue coverage. No complications were registered in the postoperative period and after 23 days of follow-up the patient was discharged from the hospital (Fig. 4).
<table>
<thead>
<tr>
<th>Biologic</th>
<th>Source</th>
<th>Processing</th>
<th>Sterile</th>
<th>Indications</th>
<th>Components</th>
<th>Advantages</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>AlloDerm</td>
<td>Cadaveric human skin</td>
<td>Processed to remove cells and antigenic components</td>
<td>No</td>
<td>Breast, pelvic, and head and neck reconstruction; abdominal hernia repair</td>
<td>Collagen, hyaluronic acid, elastin, fibronectin, proteoglycans, vascular channels</td>
<td>Tolerates irradiation</td>
<td>Non-cross-linked; requires rehydration time</td>
</tr>
<tr>
<td>Strattice</td>
<td>Percine ADM</td>
<td>Proprietary process that removes cells with antigenic response</td>
<td>Yes</td>
<td>Breast reconstruction, abdominal wall repair</td>
<td>Undisclosed</td>
<td>One of original ADMs; well documented in literature</td>
<td>Non-cross-linked</td>
</tr>
<tr>
<td>DermaMatrix</td>
<td>Human skin</td>
<td>Sodium chloride used to remove epidermis and dermis</td>
<td>Yes</td>
<td>Nasal, lower eyelid, and breast reconstruction; cleft palate repair; abdominal wall repair</td>
<td>Collagen, elastin</td>
<td>Rapid rehydration</td>
<td>Non-cross-linked</td>
</tr>
<tr>
<td>SurgiMend</td>
<td>Fetal bovine dermal collagen</td>
<td>Process designed to remove cellular components and potentially infectious agents from raw material</td>
<td>Yes</td>
<td>Muscle flap reinforcement; hernia repair, including abdominal, inguinal, diaphragmatic, femoral, scrotal, umbilical, and incisional hernia repair</td>
<td>Type I and type III collagen</td>
<td>Easy to handle and suture, rehydrates in minutes</td>
<td>Non-cross-linked</td>
</tr>
<tr>
<td>Veritas</td>
<td>Bovine pericardium</td>
<td>Proprietary process that caps free amine groups</td>
<td>Yes</td>
<td>Abdominal hernia repair</td>
<td>Collagen</td>
<td>Unique shapes and sizes; fenestrated to assist in fluid drainage</td>
<td>Non-cross-linked</td>
</tr>
<tr>
<td>FlexHD</td>
<td>Human allograft skin</td>
<td>No</td>
<td></td>
<td>Abdominal hernia repair, breast reconstruction, chest wall reconstruction</td>
<td>Collagen</td>
<td>Excellent strength and suture retention</td>
<td>Non-cross-linked</td>
</tr>
</tbody>
</table>

DISCUSSION
At the time of anterior chest wall reconstruction in patients with poststernotomy mediastinitis (also commonly called deep sternal wound infection), a preservation of the sternum should be the principal aim of surgical treatment. From 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 (9). Vaccum-assisted closure therapy acts as a link between radical debridement and definitive plastic coverage (6).

Since the sternal instability is a 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 (15). Other type of alloplastic materials can provide stability of the chest wall, but unfortunately there are not many publications about its use in mediastinal reconstruction (16).

Chest wall reconstruction was carried out also by using a human ADM. The authors concluded that human acellular dermis is an effective but expensive alternative to synthetic mesh in reconstruction of chest wall and diaphragmatic defects including under conditions of potential or overt contamination (17). In 2011 Huston et al (18) reported a case of chest wall reconstruction with porcine ADM (Strattice) and a latissimus dorsi myocutaneous flap. StratticeTM tissue reconstructive matrix (LifeCell, Branchburg, NJ, USA) is a porcine ADM widely applied in the plastic surgery procedures: expander/implant breast reconstruction and aesthetics (13,14), abdominal wall repair (11), burn surgery (19), among others. The biopsy of the Strattice demonstrated mild fibroblastic reaction with focal tissue integration of the matrix (20,21). Capillarie ingrowth in the matrix was clearly evident (21).

In our patient, the porcine ADM 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 ADM into the anterior chest wall. Interestingly, it had been promoted a sufficient healing of the sternal bone despite the dehiscence after the first operation performed by our team. On the other hand, cultures were negative after the operation and that logically contributed to good stability of the sternum. For that reason during the second reconstructive procedure we used only one plate in order to reinforce the sternum; the rests of pectoralis major muscles were applied just for soft tissue coverage.
Figure 1: Porcine acellular dermal matrix (Strattice) placed on the osteosynthesis of the sternal bone performed with titanium plates.

Figure 2: HE staining: a fibroelastic reaction with focal tissue integration of the matrix.
Figure 3: Sternal osteosynthesis with a titanium plate fitted over a patch of Strattice matrix.

Figure 4: (A) Sternal wound with purulent discharge, necrotic tissue and bony instability at the time of the initial consultation by our team. (B) Final outcome, 6 months after the final reconstructive procedure.
CONCLUSION

Application of porcine ADM seems to be an effective method for sternal reconstruction after mediastinitis and sternal dehiscence but further investigations are needed. In Bulgaria, the application of acellular dermal matrices is still a rare occurrence basically because of the high price and inadequate reimbursement of these biological products.

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REFERENCES

сред операции, как способности, которые влияют на артикуляцию логично би определяет для доброты стабильность на грэндия кость. Порядка наличие коэффициент стабильность, по времени на второго реконструктивной интервенции используем само сакционная блоки для стабилизации на грэндия кость. Остаточное от пекторальных ламба изолированных единоцветно как межкостное покрытие.

ЗАКЛЮЧЕНИЕ

Использование на свиньи АДМ с очертано как эффективный метод для реконструкции на грэндия кость след медиастинит и стернальная дехисценция, но по-материальные изъятия с необходимыми, за да бъде потвърдено това. В България прилагането на АДМ все още е рядко явление, основно поради високата цена на тези биологични продукти и неадекватното им реимбурашение.

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