Case report
Silver-coated prosthetic heart valve: a double-bladed weapon
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Abstract
A St. Jude Medical Silzone was implanted in a 72-year-old female, suffering from mitral valve disease. Four months later, the patient had acute cardiac failure due to partial detachment of the prosthetic valve. The mitral annulus was ulcerated and there were multiple erosions in the myocardial tissue in contact with the prosthetic valve. Histological examination revealed chronic inflammation with hemosiderine deposits and giant cells. No allergy to silver ions was found. The silver-coated sewing cuff had caused a chronic inflammatory reaction due to a toxic reaction to silver. The Silzone valve was withdrawn from the market on January 2000.

Keywords: Silver toxicity; Endocarditis; Prosthetic heart valve

1. Introduction
Prosthetic valve endocarditis (PVE) is one of the complications of heart valve replacement and its treatment represents a challenge to the surgeon. The incidence of PVE ranges up to 0.5%/patient-year for mechanical mitral valves and up to 1%/patient-year for other mechanical valves [1]. PVE is a foreign body infection predominantly based in the sewing cuff of a prosthetic heart valve. The mortality rates are high: 75% for infection occurring up to 2 months (early PVE) and 43% for infection occurring thereafter (late PVE) [1].

Many techniques have been developed to reduce the incidence of PVE, such as antimicrobial treatment (topic and systemic) and also, the use of homographs. The newest and the most promising one consists of a silver-coated, sewing cuff heart valve (St. Jude Medical Silzone) [2]. The Silzone coating is a dense layer of metallic silver deposited on the surface of individual fabric fibrils (polyethylene terephthalate polyester) that acts as a source of silver ions that inhibit colonization and attachment of microorganisms to the sewing cuff [2]. Several animal and clinical studies [3–5] have proven the anti-infective efficacy of silver-coated prostheses. The Artificial Valve Endocarditis Reduction Trial (AVERT), a multicenter, randomized trial, was created to assess the clinical efficacy of Silzone in the prevention of PVE [6]. This report describes a patient enrolled in the AVERT that developed a type IV immune response in the periprosthetic tissue after mitral valve implantation.

2. Case report
A 72-year-old female, suffered from mitral valve disease and chronic atrial fibrillation. She referred an allergic reaction (rash) after co-trimoxazole ingestion 10 years before. Echocardiography showed severe mitral regurgitation. The patient was enrolled in the AVERT and in August 1999, underwent mitral valve replacement. A St. Jude Medical Silzone, Ø 29 mm, was implanted using the interrupted suture technique (2/0 pledgetted Ticron sutures). Echocardiography showed no periprosthetic leakage and the patient was discharged 9 days after the operation.

Four months later, the patient was re-admitted because of progressive heart failure. Trans-esophageal echocardiography showed severe mitral insufficiency due to a partial detachment of the prosthetic valve, mostly on the interven-tricular septum side. Right basal pneumonia was diagnosed as well. An emergency prosthetic mitral valve replacement was necessary. At re-operation, the prosthetic valve was detached from the interventricular septum. All sutures and pledgets were in place, but on 1/3 of the circumference, sutures were detached from the mitral annulus. The annulus corresponding to the interventricular septum was ulcerated and there were multiple erosions in the myocardial tissue in contact with the prosthetic valve. No tissue covered the sewing cuff. We implanted a standard valve (St. Jude Medi-
cal Ø 31) with the same surgical technique. All bacteriological examinations were negative, except for the expectoration, in which we found *Pseudomonas aeruginosa*. Histological examination was carried out on three fragments of the mitral valve annulus of 0.7 × 0.3 × 0.2 cm, and revealed chronic inflammation with giant cells and hemosiderine deposits (Fig. 1). The patient was discharged 20 days after. A skin patch test carried out 3 months later, was negative for a type IV reaction to silver nitrate (maximal concentration, 0.7%). An international set of skin patch tests (24 classic allergens) was negative as well.

### 3. Discussion

When it first appeared, the prosthetic heart valve with a silver-coated sewing cuff seemed to be an easy and smart way to approach the PVE problem. Animal experiences showed that silver coating reduces inflammation in direct contamination models using a strain of *Staphylococcus epidermidis* that is capable of producing a biofilm [2]. De la Riviere et al. [3] studied any adverse effects of the silver coating in humans by determining blood silver levels by graphite furnace atomic absorption spectrometry, before and after the valve implantation, and nothing was detected. All the encouraging data led us to enroll our patients in the AVERT in order to assess the clinical efficacy of the silver-coated sewing cuff in reducing PVE incidence.

PVE was our diagnostic hypothesis when the patient was re-admitted, but intraoperative findings were very far from a classic PVE. The mitral valve annulus was partially destroyed and no abscess, fibrin deposits or vegetation were found. The periprosthetic tissue had multiple erosions and the interventricular septum near the valve was ulcerated. It looked like the valve burned the surrounding tissue. The histological examination of periprosthetic tissue showed a chronic inflammatory reaction with hemosiderine deposits and giant cells (Fig. 1). This histological pattern is unusual after the implantation of standard mechanic heart valves and it probably involves components of the immune system, such as T-cell lymphocytes (immune reaction type IV) [7]. No microorganisms were found in the sewing cuff, in the periprosthetic tissue or in the blood stream. Surgical, histological and bacteriological findings supported the hypothesis that this valve caused a chronic inflammatory reaction leading to its detachment. Assuming that the only difference between silver-coated sewing cuff valves and standard St. Jude Medical valves is the silver coating, there are two possible mechanisms that can produce the described histological pattern: allergy and toxic reaction to silver. Silver allergy is a well-known problem in oral pathology [8] as well as in jewelry manufacturing: 2–5% of the silver exposed population develops an allergic dermatitis [9]. Our patient had a negative silver nitrate patch test at a standard concentration of 0.7%, so we cannot evoke an allergic reaction as the mechanism behind the observed lesions. We can speculate that the lesions described are due to a direct toxic effect of silver ions on the myocarde. As Kraft et al. [10] demonstrated, pure silver implanted in striate muscle induces a persistent activation of leukocytes combined with a marked disruption of the microvascular endothelial integrity, massive leukocyte extravasation, and considerable venular dilation, probably due to the production of intracellular superoxide anions. A high silver concentration in the periprosthetic tissue could reasonably explain the described histological and clinical patterns.

The reported experience has played a major role in the interruption of the AVERT study and in the withdrawal of the Silzone valves from the market on January 2000.

Patients enrolled in the AVERT study need a more vigilant follow-up and greater attention to the signs and symptoms of paravalvular leak. Moreover, a reaction to the silver coating should be taken into account if PVE is suspected.

### 4. Conclusions

The use of the silver-coated sewing cuff heart valve should be critically judged despite its bactericidal proper-
ties. The silver-coated sewing ring, in some patients, can be a potential source of chronic inflammation that could have clinical consequences as dramatic as PVE. The reported experience has played a major role in the interruption of the AVERT study and in the withdrawal of the Silzone valves from the market, awaiting more data concerning the safeness of silver-coated medical prostheses. We believe that patients enrolled in the AVERT study need special surveillance for early detection of potential inflammatory reactions to the silver-coated sewing ring.

References


