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# The role of intraoperative antibiotic irrigation and postoperative antibiotic therapy for contaminated implantable prosthesis: in a rat model *in vivo*

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**The aim of this study was to determine the usefulness of intraoperative antibiotic irrigation solution and long-term effective antibiotic therapy for the infected prostheses.**

**Forty-five male Wistar albino rats were divided into three equal groups and a small piece of silicone prosthesis contaminated with *Staphylococcus epidermidis* was implanted into the scrotum. In the first group, the silicone pieces were irrigated with an antibiotic solution intraoperatively and antibiotic therapy was applied for 20 days postoperatively. The second group underwent only antibiotic therapy. In the third group (control) neither intraoperative irrigation nor postoperative antibiotic therapy was applied. Postoperative clinical infection was determined as follow-up. All implants were extracted 20 days after the implantation and cultured to observe the bacterial growth.**

**In the first group, in 13 rats the cultures were negative and in two rats, the cultures revealed positive bacterial growth. In the second group, in four rats the cultures were negative, in five rats the cultures were positive and six rats revealed infectious findings. In the third group, 13 rats revealed infectious findings, and in the remaining two rats the cultures were positive. The differences between three groups are statistically significant ($P < 0.05$).**

**We conclude that intraoperative antibiotic irrigation and postoperative antibiotic therapy are highly beneficial in the infected prosthesis surgery.** *International Journal of Impotence Research* (2000) **12,** 285–288.

**Keywords:** prosthesis; infection; antibiotic therapy; rat

## Introduction

During the past two decades the use of implantable prostheses has become an increasingly popular and common procedure in urology and other surgical specialties. Artificial urinary sphincters and penile prostheses are widely used for management of urinary incontinence and erectile dysfunction by many urologists. The operation carries minimal risk of morbidity; however, infection of prosthesis remains one of the most disastrous complications and almost always results in loss of the device.[1–3]

*Staphylococcus epidermidis* is the most common organism that is usually identified in clinically infected prostheses.[4–6] The large number of infections with staphylococci is explained by the ten-dency of this pathogen to produce an extracellular-matrix within which the organisms thrive and into which antibiotics cannot easily penetrate.[7]

Some investigators declared that microorganisms could be cultured on the implanted prosthesis without causing a clinical infection. Licht *et al* concluded that low colony counts of *S. epidermidis* may be found in the absence of prosthetic infection.[8] Fishman *et al* also cultured eight different organisms in the revision surgeries of noninfected penile prosthesis and concluded that a double blind control study would be required to fully assess the influence of antibiotic use during and following inflatable penile prosthesis revision.[9]

Intraoperative preventive antibiotic therapy and antibiotic irrigation solutions are widely used in prosthesis surgery.[1,4–6] But the effect of these therapies for contaminated prosthesis has not yet been investigated. We attempted to find the effect of long-term antibiotic therapy and intraoperative antibiotic irrigation for the prostheses, which were contaminated with *S. epidermidis* in an experimental study.

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## Material and methods

Forty-five adult male Wistar rats (weight 200–245 g) were divided into three equal groups. A piece of contaminated silicone prosthesis was used for implantation. The contamination of the implants was achieved by 10 µl of triptic soy broth (Difco Laboratories Inc., Detroit, MI, USA). The solution consisted of 1:200 dilution of a 0.5 Mc Farlend unit suspension, 270 ± 50 organisms were contained in logarithmic phase *S. epidermidis* strain ATCC 12228 which is well-characterized strain often employed as a reference standard for antimicrobial susceptibility testing.[10]

Silicone was implanted after the 24-hour incubation period. Another piece of silicone was cultured as control of contamination. The animals were anesthetized with intramuscular injection of a 1:5 mixture of 100 mg/ml xylazine (Miles Laboratories, Shawn, KS, USA) and 100 mg/ml ketamine hydrochloride (Bristol Laboratories, Syracuse, NY, USA). After the anesthesia, the animals were placed in supine position. The abdomen and scrotum were shaved and subsequently cleaned with betadine. After a small midline scrotal incision the contaminated silicone was placed into the scrotum under sterile conditions. All implants were fixed with unresorbable suture material. A stapler was used for skin closure because of the rats' interest to their wounds. The operated rats were housed in separate cages for 20 days.

In the first group, the silicones were irrigated intraoperatively with an antibiotic solution containing 200 mg teicoplanin (Targocid®, Hoechst Marion Roussel) and 500 mg amicacin (Amiklin®, Bristol-Myers Squibb) in 500 ml saline. This solution was ejected copiously on the implant using a sprayer. Beginning before the surgery the combination of teicoplanin 2 mg/kg/d and ofloxacin 2 mg/kg/d (Tarivid®, Hoechst Marion Roussel) was administered by intraperitoneal injection for 20 days as systemic antibiotic therapy. The second group received only systemic antibiotic therapy. The third group received no treatment during or after the surgery.

The animals were fed a standard diet and water *ad libitum*. Housing was controlled for temperature (25°C), humidity (40–60%), and light (12-hour light–dark cycle). Skin lesions with increased rectal temperature was accepted as finding of clinical infection. Twenty days after the surgery the animals were sacrificed using an intracardiac injection of a lethal dose of sodium pentobarbital after anesthetization with ketamine and xylazine. All silicones were removed under sterile conditions. A short section including the area directly beneath the skin, is aseptically cut off and sent to the microbiology laboratory in a sterile container without liquid. This section of silicone is rolled across the surface of an agar plate with sterile forceps. After overnight incubation, the colonies were counted semiquantitatively according to the method of Maki *et al*.[11]

Statistical comparison of the data was carried out using the Mann–Whitney U test. A *P*-value less than 0.05 was considered statistically significant.

## Results

In 13 rats (87%) in the first group, the cultures of the silicones were negative. In the remaining two rats (13%) the cultures revealed positive bacterial growth about 10 000 colonies of *S. epidermidis*. There were no clinical infection findings in all animals in this group.

In the second group, the cultures of the silicones were negative in four rats (27%). In five rats (33%) the cultures were positive and revealed 10 000–50 000 colonies of *S. epidermidis*. Of these nine rats in the second group, there was no clinical infection findings for 20 days. In the remaining six rats (40%) clinical infection findings occurred 4–7 days after the surgery. The explanted silicones of these six rats revealed positive bacterial growth in more than 100 000 colonies of *S. epidermidis*.

In the third group (control), 13 animals showed typical skin lesions indicating clinical infection due to *S. epidermidis*, yielding a rate of 87%. Skin lesions were small furuncles that were seen especially along the neck and the chest of the animal. Rectal temperature also increased 2–3°C approximately 4 days after the surgery. Purulent discharge was observed on the scrotal wound after 3–5 days from the surgery in four clinically infected animals in this group. The cultures of the silicones revealed *S. epidermidis* more than 100 000 colonies. In the other two animals in this group the cultures revealed 50 000–100 000 colonies of *S. epidermidis* and no clinical infection findings were observed after the surgery. The results of these three groups are summarized in Table 1. The differences between three groups were statistically significant ($P < 0.05$).

The silicone pieces cultured as control of contamination revealed more than 100 000 colonies of *S. epidermidis* in all cases.

**Table 1** Summary of the results

| | *First group* | *Second group* | *Third group* |
|---|---|---|---|
| Infected positive culture | – | 6 | 13 |
| Noninfected positive culture | 2 | 5 | 2 |
| Negative culture | 13 | 4 | – |

## Discussion

Infectious complications are extremely important in any surgical procedure but in prosthetic surgery special management is required because of the implanted foreign body. Most infections are thought to originate at the time of surgery as a result of contamination with organisms of the skin or colorectal area.[4] Many different organisms were cultured from infected prostheses but the most common infecting organism is *S. epidermidis*. The percentage in the literature varies from 35 to 65%.[4–6] Some organisms can live on the implant for a long period without causing an infection. But even a long time after the surgery *S. epidermidis*, especially, can cause a clinical manifest infection.[12] *S. epidermidis* is also cultured from clinically noninfected implants in our experimental study.

Reports in the literature describe penile implant infection indices of 1–11% for the general population.[13] Earle *et al* found 3.6% infection rate in 302 penile implantations despite intraoperative intravenous antibiotic coverage with gentamicin and cloxacillin.[14] Kabalin *et al* diagnosed nine infections among 417 total penile implants for an overall incidence of infectious complications of 2.2%.[1] *Staphylococcus epidermidis* was the most common bacterial isolate and perioperative antibiotic coverage consisting of cephazolin and aminoglycoside was used. Randrup found an infection rate of 5% in 180 operations, and *S. epidermidis* was the most common organism.[13] He also used a cephalosporin and aminoglycoside combination.

A significant number of gram-negative organisms are also recovered routinely in infections of penile implants. So a rigid adherence to a perioperative schedule of antibiotic coverage is necessary in prosthesis implantation.[12] Therefore, broad-spectrum antibiotic coverage including gram-negative enteric as well as gram-positive organisms especially *S. epidermidis* should be provided. Antibiotic agents are most protective when they are started 1–2 hours prior to surgery. This allows sufficient time for the antibiotics to achieve peak serum levels during surgery.[15]

Antimicrobial sensitivities and broad spectrum must be considered in choosing prophylactic antibiotics. Almost all authors prefer a combination therapy of a glycopeptide antibiotic or cephalosporin for gram-positive and aminoglycoside for gram-negative microorganisms.[1,2,13] We also prefer a similar combination considering methicilline resistance, since some authors declared prosthesis infection caused by methicilline resistant staphylococci.[16] Glycopeptide antibiotics are active against staphylococci including methicilline resistant strains. Teicoplanin is a complex of five closely related glicopeptides with a similar structure to that of vancomicin, but having a longer half-life.[17] Unlike vancomicin it can be given either an intravenous bolus or by intramuscular injection. Teicoplanin is a large polar molecule and, as it cannot penetrate the lipid membrane of gram-negative bacteria, it is inactive against these organisms.

Intraoperative antibiotic irrigation solution has been recommended by many authors as means of decreasing the chance of infection.[1,2,4,9] While the prosthesis is available for implantation, it is best submerged in an antibacterial agent to prevent airborne bacteria and debris from attaching. Some authors even determined the important role of intraoperative antibiotic irrigation during salvage of the clinically infected penile prostheses.[18,19] Our attempt also investigates the main role and usefulness of antibiotic irrigation in especially contaminated prosthesis.

The antibiotic content of the irrigation solution is almost the same with those used for systemic prophylaxis. Furlow and Goldwasser recommended DAGS solution that contains 500 mg neomicin, 80 mg gentamicin and 100 mg polymicin B per 1000 ml isotonic saline.[20] Carson preferred bacitracin with neomicin or gentamicin for antibiotic irrigation solution.[4] Kabalin and Kessler also used the same combination.[1] A similar antibiotic solution was used in our study, and all contaminated implants in the first study group were irrigated copiously with this solution.

All authors agree on the usefulness of perioperative antibiotic therapy but the period of postoperative antibiotic therapy is controversial. Carson suggested that antibiotics should be discontinued after the threat of bacterial colonization has passed within 36–72 h postoperatively.[4] Kabalin and Kessler continued the antibiotic therapy 7 days with an oral cephalosporin after the hospital discharge.[1] Fishman *et al* recommended postoperative oral antibiotic therapy for weeks for the patients who underwent a revision surgery of penile prosthesis without clinical infection but positive intraoperative culture.[9] In our experimental study all implants were contaminated with *S. epidermidis*, so a broad spectrum antibiotic therapy was continued 20 days postoperatively in the study groups.

In conclusion, contamination of prosthesis during surgery is an unexpected and undesirable outcome but it can occur in spite of all precautions. Taking our results into account, we are convinced that intraoperative antibiotic irrigation solution highly decreases the possibility of clinically manifest infection. When the implant is contaminated, systemic antibiotic therapy is not sufficiently preventive but intraoperative antibiotic irrigation enhances its efficacy.

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