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Triclosan-Coated Sutures in Oral Surgery

Nici chirurgiczne pokrywane triklosanem w chirurgii jamy ustnej

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Abstract

Background. The objective was to identify the microorganisms present on polyglycolic-acid braided suture material coated with triclosan used in the oral cavity and the *in vitro* evaluation of the bactericidal properties of triclosan-coated material.
Material and Methods. Material was collected from 11 patients subjected oral surgery. The first material was non-absorbable monofilamen the second triclosan-coated multifilament. Both threads were sutured simultaneously to the same wound. The suture materials were excised 7 days after surgery and placed onto transport medium plates. Identification was carried out with commercial API tests. Most of the isolated strains were classified as *Streptococcus*. *In vitro* tests were performed in two stages. The first test was carried out with the coated materials placed directly onto plates inoculated with microbes isolated from the patients. In the second test the sutures were first rinsed for 24 h in isotonic salt solution. Zones of growth inhibition were evaluated after 48 h.
Results. There was no significant difference in colony count and species of microbes isolated from triclosan-coated and uncoated material. The growth inhibition of *Streptococci* did not exceed 2 mm and was observed only with unrinsed triclosan-coated material. A larger zone of inhibition of up to 20 mm was noted only with the control strain *E. coli* ATCC 25922 with both unrinsed and rinsed material.
Conclusions. In the absence of demonstrated differences in colonization between sutures coated with triclosan and regular multifilament suture and their bactericidal properties, the choice for suture material should be its convenience for the surgeon rather than its ability for bacterial adherence (**Adv Clin Exp Med 2009, 18, 4, 401–405**).

Key words: surgical suture material, triclosan, bacterial colonization.

Streszczenie

Cel pracy. Identyfikacja mikroorganizmów obecnych na wielowłókienkowych niciach chirurgicznych pokrywanych triklosanem, zastosowanych w jamie ustnej, oraz określenie właściwości przeciwbakteryjnych tego typu wyrobu.
Materiał i metody. Materiał pobrano od 11 pacjentów poddanych zabiegom z zakresu chirurgii stomatologicznej. Rany pooperacyjne zeszyto jednoczasowo monofilamentem i nicią plecioną, pokrytą triklosanem. Identyfikacji mikroorganizmów dokonano za pomocą testów API. Badania *in vitro* przeprowadzono na niciach bezpośrednio pobieranych od pacjentów, a w teście hamowania wzrostu również na płukanych przez 24 h w soli fizjologicznej.
Wyniki. Nie stwierdzono istotnych różnic w rodzaju i liczbie drobnoustrojów izolowanych z nici pokrytych i niepokrytych triklosanem. Strefa zahamowania wzrostu dla szczepu *Streptococci* nie przekroczyła 2 mm i zaobserwowano ją tylko dla nici niepoddanych płukaniu. Strefę > 20 mm stwierdzono tylko dla testowego szczepu *Escherichia coli*.
Wnioski. Brak różnic w kolonizacji nici chirurgicznych oraz ich mała skuteczność przeciwbakteryjna pozwala stwierdzić, że podstawowym czynnikiem podczas wyboru materiału szewnego w dalszym ciągu pozostają jego właściwości mechaniczne i kryteria ekonomiczne, a nie potencjalne oddziaływanie przeciwbakteryjne (**Adv Clin Exp Med 2009, 18, 4, 401–405**).

Słowa kluczowe: nici chirurgiczne, triklosan, kolonizacja bakterii.

There are some potential risk factors of wound infection in oral cavity surgery related to the suture material. Early studies demonstrated that the adherence of microbials to suture material varies depending on the specific bacterial species, the suture structure, and the chemical composition of the device [6, 8]. It has been clearly stated in the literature that monofilament sutures are less susceptible to colonization by microbes than multifilament (polyfilament, braided). Unfortunately, the former are not as "handy" for the doctor and less convenient for the patient. They are more difficult to handle because of a lack of intrinsic stretching ability; they have material memory which can create slippage and cause knots to untie.

The development of triclosan-coated multifilament suture material represents a recent effort aimed at reducing postoperative surgical-site infections by preventing contamination of the surgical suture within the operative wound. Triclosan (IUPAC name: 5-chloro-2-(2,4-dichlorophenoxy) phenol) is a potent wide-spectrum antibacterial and antifungal agent and has been used effectively in consumer products for over 30 years.

The problem of the ability of pathogenic microorganisms to colonize suture material is also common in dental and maxillo-facial literature [1, 4–6, 10, 12]. Studies on sutures which have antibacterial properties that can protect the wound have been carried out [3, 11]. The issues under discussion are mainly related to general surgery, orthopedics, and plastic surgery. However, this undervalued problem exists in oral cavity surgery as well [1, 5, 9, 13]. The oral cavity provides an ideal environment for many species and genera of microorganisms. Sutures used in oral surgery should avoid or limit bacterial adhesion and proliferation to those parts exposed to oral fluids. One can distinguish various permanent and temporary bacterial flora whose quantity depends on various endogenous and exogenous factors. The bacteria significantly attributable to both oral cavity physiology and pathology include *Streptococcus viridans*, Gram-positive bacilli such as *Actinomyces*, *Eubacterium*, *Lactobacillus*, and *Propionibacterium*, Gram-negative *Neisseria*, and the Gram-negative bacilli *Haemophilus*, *Actinobacillus*, *Campylobacter*, *Prevotella*, and *Porphyromonas*. Fungi are reported, most notably *Candida albicans* species.

Throughout one's life, the oral microflora undergoes changes. Bacteria play a significant role in oral cavity inflammations. Within the oral cavity the microflora remains inherently stable and collects in small reservoirs denoted by the topographical anatomy of the oral cavity. An important factor for infection could be the invasive nature of treatment related to oral or maxillo-facial surgery [4, 5]. Wound debridement and suture materials in dental surgery are an unquestionable challenge for the operating surgeon. On the one hand, the good vascularization of the oral region is conducive to fast healing, but on other the presence of saliva-specific bacterial flora and conditions related to speech, mastication, and food swallowing demand particular selection of a suture. The problem is made more significant in cases when treating patients with immune deficiency or susceptibility to endocarditis. Antibacterial prophylaxis is mainly carried out perioperatively; however, the incidence of bacteremia occurs during suture removal [5].

The aim of this study was to compare the genera and amounts of bacteria colonizing triclosan-coated and uncoated polyglycolic braided sutures. The null hypothesis was that triclosan-coated material possesses long-lasting bactericidal properties.

Material and Methods

The study was carried out on the polyglycolic-acid, braided, absorbable material Safil (BBraun, Aesculap AG, Germany). Suture size was 3/0. The sutures were impregnated with freshly prepared 5% w/v triclosan solution [5-chloro-2-(2,4-dichlorophenoxy)phenol, Irgasan DP 300; Brenntag] in a system of solvents by soaking them for 60 s and air drying for 24 h at room temperature in a laminar flow cabinet. The procedure was performed in a sterile manner. The solvents hexane and propan-2-ol (Chempur) were previously mixed in a volumetric ratio of 7:3 and stored over molecular sieves prior to use.

The samples for testing were taken from patients of the Second Maxillo-Facial Surgery Clinic of the Medical University, Warsaw, appearing for dentoalveolar surgical procedures. Informed consent was obtained from each patient.

Regular suture and triclosan-coated material were sutured simultaneously to the same wound. The suture materials were excised 7 days after surgery and placed onto transport medium plates. Each sample was placed 3–4 hours after collection into a test tube with 5 ml of isotonic salt solution, shaken for 10 min at 270 rpm, inoculated onto Columbia agar with 5% sheep blood, and incubated in aerobic, anaerobic, and increased carbon dioxide atmospheres.

Colonies were isolated and initially identified from morphological features and Gram-method staining. Further identification was carried out with the commercial tests API 32 Strep, API 20A, ID32 GN, and ID32 Staph.

During the direct activity tests, the triclosan-coated suture material was cut into 2-cm pieces and placed onto Mueller Hinton agar plates previously inoculated with the bacteria isolated from the patients. The second suture was put in a probe with 100 ml of isotonic salt solution. The sample was then placed onto a mixer set at 270 rpm for 24 h at 37°C. After thorough rinsing, the material was cut into 2 cm pieces and placed onto an analogous agar plate. The results were recorded after 48 h.

Results

There was not a well-defined difference in the quantity and kind of bacterial species isolated from washings of the triclosan-coated and uncoated materials taken from the same patient. Miscellaneous bacterial flora were found in both kinds of suture material. The prevailing bacteria isolated from the two groups were the oral cavity streptococci *Streptococcus oralis*, *S. mitis*, *S. salivarius*, *S. anginosus*, *S. sanguis*, and *S. mutant*. Another sparsely isolated species was *Enterococcus faecalis* and anaerobic incubation allowed the isolation of *Bacteroides* and *Actinomyces.* These results do not show that triclosan coating of the suture material influences bacterial flora in a surgical wound in the oral cavity.

The results of direct antimicrobial activity evaluation varied. The unrinsed suture material was apparently active against the above-mentioned microbials, but the zone of inhibition was less than 2 mm. There was no bactericidal action noted for the rinsed material under the same conditions. The only susceptible species was *Escherichia coli* ATCC 25922, used as a control; this species is not commonly isolated from the oral cavity. The zone of inhibition for the unrinsed material reached 12 mm and for rinsed samples 8 mm. The results of this second experiment are also presented in Table 1.

Discussion

According to these results, it is difficult to determine which specific sutures were susceptible to the colonization of microbes because the isolated species were present on both the triclosan-coated and regular uncoated multifilament suture in the same patients. The contact of the suture material with oral cavity flora is clearly significant.

Inhibition of microbial growth for specific species did occur but was most evident for *E. coli.* It is worth mentioning that the rinsed material exhibited much less microbial action. These results may show that either triclosan was released to the substrate in a very small amount or did not sufficiently impregnate the material to remain on the surface after 24 h of washing. However, preliminary analysis by FTIR-ATR infrared spectroscopy showed the triclosan peak at 1474 and 1490 cm^{-1} (PGA suture T2 *vs.* PGA suture S1 on Figure 1).

The results of some studies suggest that antimicrobial-coated sutures exhibit an inhibitory or bactericidal activity on bacteria commonly cultured form surgical wounds, especially *Staphylococcus aureus* and *Escherichia coli* [3, 11]. Researchers often conduct tests on experimental models of wound infection in animals. The specific character of oral cavity bacterial flora is somehow different. Aerobic and anaerobic bacteria are usually isolated in nearly equal quantities (cfu/ml) on each suture material [1]. The most common strains are *Streptococci*, *Enterococcus faecalis*, *Bacteroides*, and *Actinomyces*.

Research into the ideal sutures for oral mucosa dressings should not only include their biocompatibility, but serious consideration must also be given to their mechanical compliance and behavior. The suture should be resistant to lengthening and rupture, but must be delicate enough to protect and safeguard the mucosa as well. The ideal material should be bacteriostatic, without adherence, to avoid microbe proliferation and wound penetra-

Table 1. Zones of bacterial inhibition

Tabela 1. Strefy zahamowania wzrostu bakterii

Microbes (Drobnoustroje)	Triclosan-coated Safil 3/0 unrinsed (Safil 3/0 pokryty triklosanem, niepłukany)	Triclosan-coated Safil 3/0 rinsed in isotonic salt solution for 24 h in 37°C (Safil 3/0 pokryty triklosanem, płukany w soli fizjologicznej przez 24 h w temperaturze 37°C)
Streptococcus sp. *Enterococcus faecalis* Bacteroides Actinomyces	zone of inhibition < 2 mm	no inhibition
Escherichia coli ATCC 25922	zone of inhibition = 20 mm	zone inhibition = 8 mm

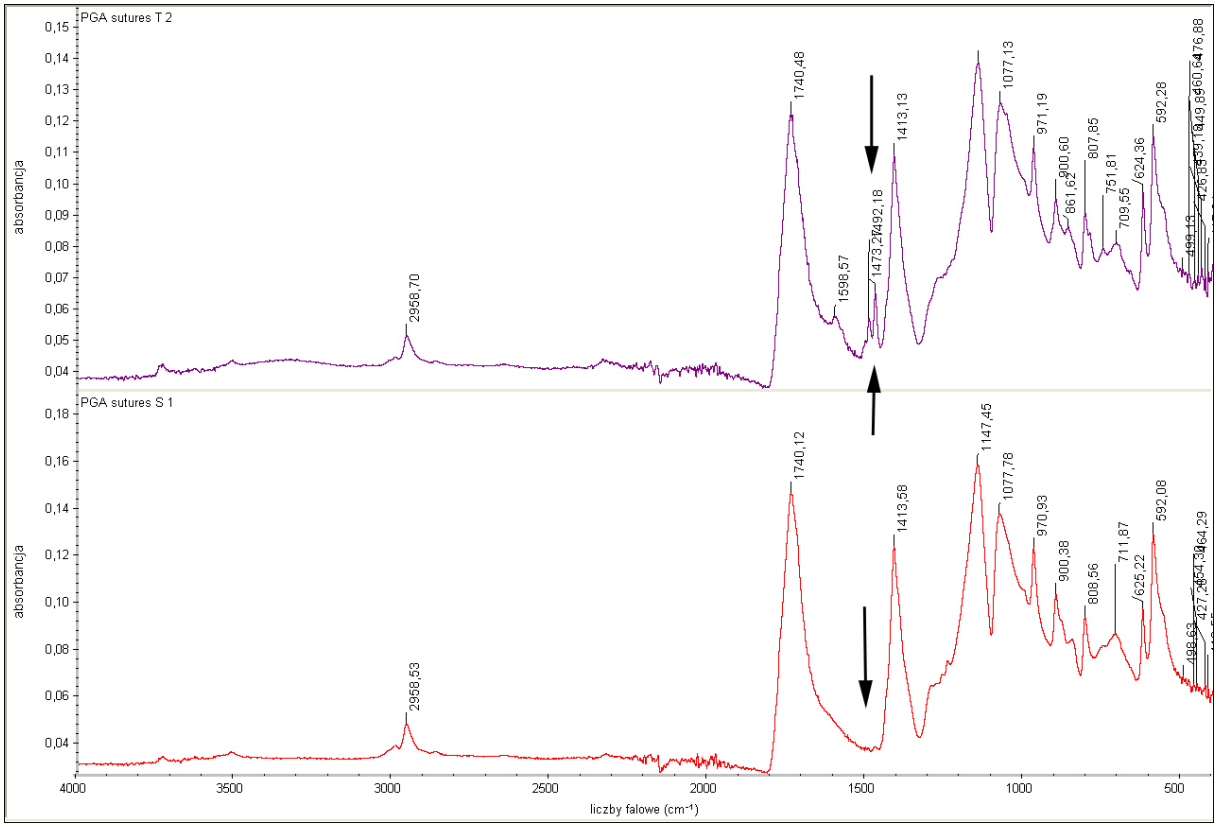

Fig. 1. FTIR-ATR infrared spectrum with marked triclosan peak (1474 and 1490 cm^{-1}); PGA suture T2

Ryc. 1. Widmo podczerwone FTIR-ATR z zaznaczonym pikiem triklosanu (1474 i 1490 cm^{-1}); nić chirurgiczna T2

Fig. 2. Multifilament suture coated with triclosan

Ryc. 2. Wielowłókienkowa nić chirurgiczna pokryta triklosanem

tion [6, 7, 9]. Besides their desirable antibacterial properties, sutures have to be neutral for adjacent tissues to allow the natural healing process [12].

In the absence of proof of differences in colonization between triclosan-coated and regular multifilament suture, it is difficult to promote the usage of the more expensive triclosan-coated suture material in the field of dentoalveolar surgery. However, the confirmed colonization by pathogens on sutures leads to the recommendation that sutures be removed as early as possible after surgery is performed to eliminate or limit the reservoir for oral pathogens. Sutures may be potential risk factors for bacterial penetration and proliferation within the wound. Therefore research into the ideal suture should always combine good physical attributes with proven anti-microbial properties.

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