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Assessment of silver-coated urinary catheter toxicity by cell culture

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Summary. The toxicity of silver-coated urinary catheters was assessed using a cell culture technique. The inhibitory effect of catheter extracts on the uptake of ^{3}H-labelled thymidine by mouse fibroblasts was measured. The results show that silver-coating had no toxic effect whereas silvernitrate and silversulphate coating did have a toxic effect.

Key words: Toxicity - Silver - Urinary catheters - Cell culture

Introduction

During the last decade there has been a growing interest in the problem of catheter-induced urethritis and catheter material toxicity. Recent studies have shown that cell culture techniques may be used for the assessment of the toxicity of catheters [2, 5, 7]. Previous studies have shown that silver-coated catheters may prevent the development of catheter-associated bacteriuria [1, 3, 6]. However, the toxicity of different silver compositions, coated on to catheters, have not been tested using a cell culture technique. The aim of this study was to test the toxicity of silver-coated catheters using a cell culture technique.

Materials and methods

Various catheters of different composition and coating were used (Table 1). The uncoated and silver-coated were of the same brand and batch number. All experimental work was conducted with coded catheters and extracts to prevent observer bias.

10 cm^2 of the midsection of the catheter to be tested was placed in a vial containing 5 ml of the culture medium. After incubation at 37° C for 48 h the extract was diluted with medium to give final extract concentrations of 10%, 20%, 40%, 70% and 100%. Cell monolayers of mouse fibroblast were established in plastic multiwell plates. One ml of the cell medium was then replaced by the catheter extract from the prepared dilutions. Thereafter the plates were incubated for further 48 h. Controls were provided using culture medium without extract (positive control) or with 5% formalin in medium (negative control).Each extract concentration was prepared and assessed in triplicate.

One hour before termination of the cultures 1.0 µCi of ^{3}H-thymidine was added to each well. The cells were then rinsed with ice-cold 1.5% perchloric acid, and 0.7 ml of 5% perchloric acid added to each well and heated to 65°C for 1 h. After cooling, the fluid was transferred to a scintillation vial and the counts per min for each well was recorded. Results were expressed as the mean ($N = 3$) percentage of control plotted against extract concentration. The extract concentration which depressed uptake to 50% of control (IC_{50}) was determined for each catheter. In a recent study it has been shown that high IC_{50} values are associated with catheters that produce the least amount of urethral inflammation [5].

Results

The effect of different concentrations of catheter extract on the uptake of thymidine is shown for the mouse fibroblasts in Fig. 1. The only catheters which did not inhibit thymidine uptake were the silicone and

Table 1. Mean IC_{50} values with coefficient of variation calculated using mouse fibroglasts (L929) for range of catheters assessed

Catheter	IC_{50} mean	Range (%)
Latex	21.7	4.6
Silver-coated latex	71.2	7.8
Silver nitrate-coated latex	36.3	6.4
Silversulphate-coated latex	43.8	7.1
Teflon (coated latex)	55.3	6.2
Silver-coated teflon	81.2	5.2
Silver nitrate-coated teflon	62.4	7.2
Silver sulphate-coated teflon	64.9	6.3
Silicone	nontoxic	-
Silver-coated silicone	nontoxic	-
Silvernitrate-coated silicone	66.4	8.1
Silversulphate-coated silicone	75.6	7.2

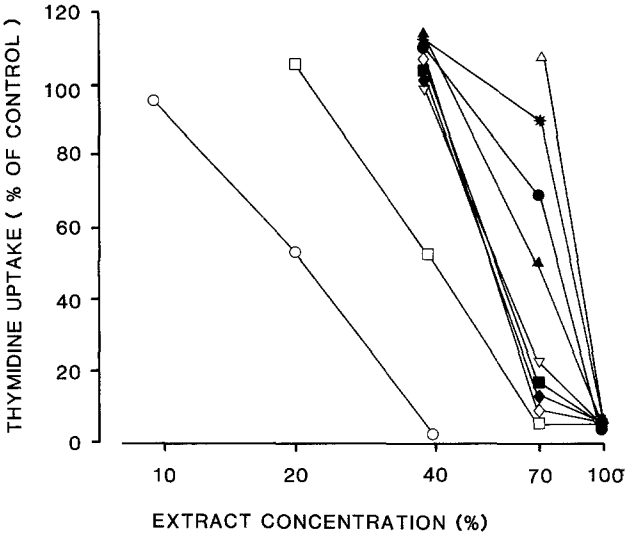

Fig. 1. Effect of catheter extract concentration on uptake of ^{3}H-thymidine into mouse fibroblasts. Latex (○), silver-coated latex (●), silvernitrate-coated latex (□), silversulphate-coated latex (■), teflon-coated latex (◇), silvercoated teflon (△), silvernitrate-coated teflon(▽), silver sulphate-coated teflon (◆), silvernitrate-coated silicone (▲) and silversulphate-coated teflon (★). The nontoxic silicone and silver-coated silicone are not shown

silver-coated silicone ones whereas silvernitrate-coated silicone and silversulphate-coated silicone catheters inhibited thymidine uptake. The IC_{50} values for each catheter is shown in Table 1. As seen silver-coating of latex and teflon increases the IC_{50} value significantly ($P<0.01$) as compared to uncoated, silvernitrate- or silversulphate coating.

Discussion

Most urinary catheters are formed over a rigid internal wire rod which is repeatedly immersed in a vat of the latex or silicone, used as the main catheter component. Further solutions may then be applied as an external coating which is responsible for the surface smoothness. The latter may also be used to reduce toxicity.

Previous studies by Nacey and associates [5] have shown that there is no difference in IC_{50} values between fibroblasts and prostate epithelial cells indicating that mouse fibroblasts appropriate cells for the evaluation of toxicity. They have also shown that there is a significant correlation between the cell culture technique and an animal model [4]. This close correlation indicates that it may be possible to predict the degree of urethral inflammation from the value of the IC_{50}. The results obtained indicate that by coating catheters with silver, the toxicity is significantly reduced. However, coating with silvernitrate or silversulphate does not appear to be of value.

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