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MODIFICATION OF THE SURFACE CHARACTERISTICS OF POLYMER MONO FILAMENTS BY HYDROGEL COATING

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Bacterial adhesion to polymeric monofilament fibres, of the type used for sutures and as marker tails for intrauterine contraceptive devices, has been implicated in the developement of infection (Sugarman and Musher 1981). Such attachment has frequently been related to the surface free energy (sfe) of the material,with minimal adhesion occuring to hydrophilic surfaces i.e. those with a low sfe (Pringle and Fletcher 1983). Other parameters, such as microrugosity, have also been suggested to influence bacterial adhesion; increased roughness resulting in greater attachment (Wilkins et al 1989). One means of reducing bacterial adhesion to a substrate may be to alter the surface characteristics such that the sfe is lowered and/or the microrugosity reduced. In this study monofilament fibres have been coated,by three different methods, with the hydrogel poly (2-hydroxyethyl methacrylate) (PHEMA), and the critical surface tensions (γ_c) and microrugosity of the composite material investigated.

Nylon threads were coated with PHEMA by:- i) Mutual irradiation,where threads were immersed in a 10% (v/v) HEMA solution in 95% (v/v) ethanol (degassed for 10 mins to remove oxygen) followed by exposure to 0.25 Mrad from a cobalt-60 source. ii) Pre-irradiation, where threads were irradiated, in vacuo, as before, dip-coated, in a 10% (v/v) HEMA solution, and then air-dried at room temperature for 1 hour. iii) Dip-coating in a 5% (w/v) PHEMA solution in 95% (v/v) ethanol, followed by air-drying, as before.Polyester and polyvinylidene chloride (PVDC) threads were also coated, but by dip-coating only. All coated threads were stored in distilled water for at least 24 hours prior to use. Values of γ_c for PHEMA coated and uncoated threads were calculated by measuring the contact angles (θ) of a series of organic liquids placed on the polymer surface. Surface tensions of these liquids were determined at 20°C using a Du Nouy tensiometer. Zisman plots were made of cos θ against the liquid surface tension for each thread,and from these γ_c was calculated (Zisman 1964). Surface microrugosity of the threads was investigated using scanning electron microscopy. Results were statistically analysed using two-tailed Mann-Witney U-tests.

Method of Coating	γ_c (mNm^{-1}) ± S.D.
Mutual irradiation	39.8 ± 0.9
Pre-irradiation	39.1 ± 0.9
Dip-coating	39.8 ± 0.3

Table 1:- γ_c values of nylon threads coated by different methods (n=6)

Thread Type	γ_c (mNm^{-1}) ± S.D.	
	Uncoated	Dip-coated
PVDC	44.1 ± 0.5	39.2 ± 0.1
Polyester	43.6 ± 0.1	39.8 ± 0.2
Nylon	42.7 ± 0.1	39.8 ± 0.3

Table 2:- γ_c values of dip-coated and uncoated threads (n=6)

The results show that different methods of coating produced threads with the same γ_c values (Table 1), and that dip-coating significantly reduced γ_c of different threads to the same value ($p<0.05$) (Table 2). Values of γ_c obtained for uncoated threads differ from those quoted in the literature,for pure polymers, but the polymeric materials, used here, contain various chemicals introduced during manufacture, such as dyes and plasticizers. Electron micrographs showed that threads were coated with PHEMA using any of the three techniques, but that the method involving pre-irradiation reduced microrugosity to the greatest extent. It is concluded that when monofilaments are coated with PHEMA they adopt the surface characteristics of the hydrogel layer, irrespective of the thread type. In this way the thread surface is rendered more hydrophilic and smoother, making it less likely to support bacterial adhesion. The dip-coating technique proved a rapid, convenient method of coating threads, although the hydrogel layer, in this case, will not be as strongly bound, to the substrate, as the other techniques.

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