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## Microbial adherence to cosmetic contact lenses

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### ABSTRACT

**Aim:** To investigate whether cosmetic contact lenses (CCL) with surface pigments affect microbial adherence.

**Method:** Fifteen brands of CCL were purchased from optical, non-optical retail outlets, and via the Internet. A standardized rub-off test was performed on each CCL (five lenses per brand) to confirm the location of the pigments. The rub-off test comprised gentle rubbing on the surfaces of each CCL with wetted cotton buds for a maximum of 20 rubs per surface. A new set of CCL (five lenses per brand) were incubated in *Pseudomonas aeruginosa* overnight. Viable counts of adhered bacteria were determined by the number of colony-forming units (CFU) on agar media on each lens. The adherence of *P. aeruginosa* as well as *Staphylococcus aureus* and *Serratia marcescens* to three brands of CCL (A–C) (five lenses per brand) were also compared to their adherences on their clear counterparts.

**Results:** Only two of the 15 brands of CCL tested (brands B and C) had pigments that did not detach with the rub-off test. The remaining 13 brands of CCL all failed the rub-off test and these lenses showed higher *P. aeruginosa* adherence ( $8.7 \times 10^5$ – $1.9 \times 10^6$  CFU/lens). Brands B and C lenses showed at least six times less bacterial adhesion than the other 13 brands. Compared to their clear counterparts, bacterial adherence to brands B and C lenses did not differ significantly, whereas brand A lenses showed significantly higher adherence.

**Conclusion:** Surface pigments on CCL resulted in significantly higher bacterial adherence.

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### 1. Introduction

The use of cosmetic contact lenses (CCL) (also known as beauty or decorative contact lenses) has become increasingly popular especially in Asian countries including Korea, Taiwan, Singapore and China [1,2]. The wearers of these contact lenses are usually teenagers and adolescents [3]. CCL include coloured lenses and limbal-ring lenses which are used to change the colour or the normal appearance of the eye. Many such lenses are of plano power [3]. However, like conventional contact lenses worn for correction of refractive errors, use of these lenses can also cause significant complications such as microbial keratitis, if they are not handled properly [4].

Because of the increasing popularity of CCL, they are now classified as medical devices in the United Kingdom [5], United States [6], China [7] and Korea (personal communication). The safety and the effectiveness of these lenses are overseen by the Food and Drug Administration (FDA) or equivalent in these countries. In Hong Kong, contact lenses are not classified as medical devices and are not subjected to registration prior to marketing. Practitioners in

Hong Kong are not allowed to supply contact lenses to patients without conducting eye examinations or without valid prescriptions. However, the law only regulates licensed optometrists and does not apply to the general public. Patients may purchase contact lenses, including CCL, on the Internet or at retail or cabinet stores (shop selling different kind of cosmetic accessories, including CCL, displayed in glass cabinets). There are many reports of infectious keratitis in the literature associated with the use of CCL [3,4,8–10] and most of these patients obtained their contact lenses without having any proper contact lens fitting procedures, or receiving any contact lens handling guidelines from licensed eye care professionals. Sauer and Bourcier [4] reported that patients who had worn CCL and developed microbial keratitis were usually relatively young and new to contact lens wear. Patients who purchased contact lenses (not exclusively CCL) via the Internet have been shown to be less compliant with regards to the use and care of contact lens such as having eye examinations at least once a year [11]. Stapleton et al. [12] also found an increased risk of microbial keratitis in patients purchasing lenses on the Internet.

The quality of the CCL is another concern which requires attention. A pilot study [13], aimed to determine if the pigments could be easily rubbed off using a standardized rub-off test, showed that only one out of five commercially available brands tested demonstrated permanency of pigments on the lens. Lenses with pigments

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**Table 1**  
Properties of the contact lenses.

Purchased from	Lens	Product name	Company	FDA group	Material	Dk	Water content (%)	Color	Color printing/process
Optical shop	A1	Tutti Circle Color	Bescon	I	Polymacon	8.4	38	Brown	INA
	A2	Ultraflex 38	Cooper Vision	I	Polymacon	8.4	38	Clear	N/A
	B1	Freshlook Illuminate	Ciba Vision	II	Nelfilcon A	26	69	Rich Brown	Embedded
	B2	Dailies AquaComfort Plus	Ciba Vision	II	Nelfilcon A	26	69	Clear	N/A
	C1	1 Day Acuvue Define	Johnson & Johnson	IV	Etafilcon A	28	58	Vivid	Sandwich process
	C2	1 Day Acuvue Moist	Johnson & Johnson	IV	Etafilcon A	28	58	Clear	N/A
	D	Perfect Eyes Big Eye Color	Unicon Company	I	HEMA/MAA	20.5	42	Party Brown	INA
	E	One Day Delight Max HydrationPlus	St Shine Optical	I	Filcon I	12.8	42	Brown	Embedded
	F	One Day Delight Max2 HydrationPlus	St Shine Optical	I	Filcon I	12.8	42	Hazel	Embedded
	G	One Day Delight Max3 HydrationPlus	St Shine Optical	I	Filcon I	12.8	42	Chestnut Brown	Embedded
	H	Lacelle	St Shine Optical	I	Hefilcon A	11	42	Tender Brown	Embedded
	J	Lacelle Color	St Shine Optical	I	Hefilcon A	11	42	Sparkling Gold	Embedded
	K	Freshlook One-day	Ciba Vision	II	Nelfilcon A	26	69	Pure Hazel	Embedded
	L	aquaSoft Color 1 Day	Unicon Optical	II	HEMA/MMA	21	55	Brown	INA
	M	Crystal-i 1 Day	E & E Optics (HK)	II	HEMA	8.4	38	Brown	INA
Cabinet store	N	Magic Color	GEO Medical	I	pHEMA	INA	42	Brown	INA
	P	Neo Cosmo	Neo Vision Co. Ltd	I	pHEMA	INA	45	Brown	INA
Internet	Q	Freaky	INA	INA	INA	INA	UV Glowing Blue	INA	

NA – not applicable; INA – information not available.

easily rubbed off were either obtained from cabinet stores or the Internet and the brand that passed the test was purchased from an optical shop.

Because of the increasing popularity of CCL, there is an urgent need to determine the safety of these lenses. To date, most of the literature on microbial adherence to contact lenses concerns adherence to hydrogel [14–26] or silicone hydrogel contact lenses [25,27–37]. As there has been no previous report, this study aimed to investigate microbial adherence to CCL.

## 2. Methods

### 2.1. Contact lenses

Fifteen brands of CCL (lenses A–Q) were tested. Samples of 12 brands were purchased from optical shops from registered optometrists, two were purchased from cabinet stores and one was purchased on the Internet (Table 1). The colour of these lenses was limited to Brown or Hazel if available. Clear counterparts of brands A–C were also studied. They were of the same material and water content as brands A–C (not taking manufacturing process into account).

### 2.2. Rub-off test

Before the commencement of the study, a standardized rub-off test was developed and used to determine if the pigments of a CCL were coated on the lens surface. The test involved gentle rubbing (applied force between 110–230 g) of each lens surface with a wetted cotton bud for a maximum of 20 times. Each CCL surface was rubbed with a force equivalent to those used when cleaning a lens. Pigments coming off the lens surface were determined by examining the tip of the cotton bud after each rub. Lenses with no pigments rubbed off after 20 rubs were considered to have passed the test (i.e. pigments were not coated on the surfaces) whereas lenses with pigments transferred to the cotton bud from either surface were considered to have failed the test. The rub-off test was performed on all CCL. Five lenses of each brand were tested.

### 2.3. Bacterial suspension and adherence

A new set of each of the 15 brands (five lenses of each brand) was challenged with *Pseudomonas aeruginosa* ATCC 9027. A1, B1, and C1 lenses and their clear counterparts (A2, B2 and C2) were also challenged with *Staphylococcus aureus* ATCC 6538 and *Serratia marcescens* ATCC 13880. The bacterial strains were those recommended by the International Organization for Standardization (ISO) 14729 used for testing efficacy of contact lens disinfection solutions. Nutrient agar plates were used for the cultivation of bacterial strains. A single bacterial colony from the agar plate was cultured in 10 mL Tryptone Soya Broth overnight at 37 °C in ambient air for 24 h. The cells were then harvested by centrifugation (CR 4-12, Jouan Inc, Winchester, VA) for 10 min (2000 × g at room temperature). The supernatant was discarded and the pellet was washed in sterile phosphate buffered saline (PBS) twice before they were resuspended in PBS. The concentration of each inoculum was adjusted spectrophotometrically (Spectronic 20 Gensys Visible Spectrophotometer, Spectronic Instruments Inc, Rochester, NY) to give an optical density of 0.10 at 660 nm which is approximately equivalent to 10<sup>8</sup> colony forming unit (CFU) mL<sup>-1</sup>. Lenses were incubated in bacteria suspension immediately after they were removed from the blister packs or storage vials. The new, sterile contact lenses were transferred with sterile forceps and soaked in 2 mL of 10<sup>8</sup> CFU mL<sup>-1</sup> suspension and incubated at 37 °C for 24 h on a plate shaker at 125 rpm.

### 2.4. Enumeration of viable micro-organisms

After 24 h, the lenses were removed aseptically and rinsed gently with 4 mL PBS to remove loosely attached micro-organisms before being transferred to bijoux bottles containing 10 mL sterile PBS. Each lens was then vortexed vigorously for 1 min to remove the adhered micro-organisms and 0.1 mL diluted aliquot was plated out on nutrient agar plates and spread evenly using a sterile glass hockey stick. All plates were incubated at 37 °C for 24 h and the organisms adhered to the lenses were enumerated using an automated colony counter (aCOLyte colony counter, Synbiosis, Frederick, MD, USA) with a count between 30 and 300 colonies.

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