cantly affecting their physical properties. Benzalkonium chloride (BAC), a quaternary ammonium compound that has been used as a preservative in ophthalmic and contact-lens solutions, was also added to orthodontic composite resin. Incorporation of BAC in composite material added antimicrobial properties to the original compound without altering its mechanical properties, but the effect of aging on the composite’s physical properties was not investigated.

The objectives of this study were to (1) assess the antimicrobial properties of orthodontic composite resin when combined with various antimicrobial agents, (2) evaluate the effect of antimicrobial agents on the mechanical property of the composite material, (3) study the effect of aging on the mechanical property of the modified composite, and (4) test the in-vitro release of the antimicrobial agents from the modified composite.

MATERIAL AND METHODS

Unite bonding adhesive (3M Unitek, Monrovia, Calif), a no-mix orthodontic adhesive, was used for this study. It was modified by the addition of antimicrobial agents. The modified adhesive was formed into tablets for testing and was used to bond brackets to extracted teeth. Stainless steel Heggt brackets with curved bases (256-650 series, TP Orthodontics, LaPorte, Ind) with bondable mesh were used.

The antimicrobial agents used were BAC (Somu Organ-Chem, Bangalore, India), chlorhexidine base (Glide Chem, New Delhi, India), and triclosan (Ipc Laboratories, Mumbai, India). All antimicrobial agents were procured in powdered forms and used as such. The amount of antimicrobial agent added to the paste was determined on the basis of their concentrations in various formulations (mouth rinses, dentifrices, and ophthalmic preservatives). Therefore, we decided to achieve final concentrations 0.1% (w/w) for BAC, 0.3% (w/w) for triclosan, and 0.2% (w/w) for chlorhexidine in the adhesive paste. The sample comprised 1 control group (unmodified resin) and 3 experimental groups (resin modified with BAC, triclosan, and chlorhexidine).

Ten tablets of each type were made in a brass tablet mold, 7 mm diameter by 3 mm thick. The specimens were sterilized with ethylene oxide gas for 5 hours and subsequently degassed for at least 48 hours.

Minimum inhibitory concentration (MIC) of the 3 antimicrobial agents was determined by the macrobroth dilution method. The antimicrobial agent was diluted in 2 mL of Mueller-Hinton broth, each containing 1 mL of the medium. Three or 4 colonies of S. mutans were inoculated into 3 mL of tryptic soy broth and incubated at 37°C for 2 to 6 hours. One mL of the bacterial inoculum was inoculated into 1 mL of Mueller-Hinton broth with different concentrations of antimicrobial agent. With each test, growth control was included. The tubes were incubated at 37°C for 24 hours and examined. The smallest concentration of antimicrobial agent that inhibited bacterial growth was considered the MIC.

Lawn culture of S. mutans was prepared on blood agar by swabbing. A sterilized tablet of composite resin containing the antimicrobial agent was placed at the center of the agar plate. The plate was incubated at 37°C for 24 hours and examined for any zone of inhibition around the tablet.

One tablet of each group was put into 1 mL of tryptic soy broth. One drop of 6-hours growth of S. mutans in tryptic soy broth was inoculated. The tube was incubated at 37°C for 24 hours and examined for bacterial growth.

Eighty human premolars extracted for orthodontic purposes were collected. The teeth were cleaned of blood and saliva and stored in distilled water at room temperature. These teeth were noncarious, unrestored, and without developmental defects on the enamel surfaces. The study design required the premolars to be divided into 2 sets of 40 teeth each. One set of teeth was tested 24 hours after bonding; the second set was tested after 25 days of storage in distilled water. In each set, the teeth were randomly allocated to 4 groups: control, composite modified with BAC, composite modified with triclosan, and composite modified with chlorhexidine.

Shear bond strength was tested with a universal testing machine (AG-I series AUTOGRAPH, Shimadzu, Kyoto, Japan) having a capacity of 1 ton (1000 kgf). The brackets were shear tested to failure by using a load cell of 500N (51 kg) and a crosshead speed of 0.5 mm per minute.

Time-dependent release of antimicrobial agents from the composite tablets into water was monitored spectrophotometrically. Absorbance readings were made by using a double-beam spectrophotometer (UV-160, IPC UV visible spectrophotometer, Shimadzu). The release of the 3 antimicrobial agents was studied for 25 days (absorbance readings were made at 24 hours, and at days 5, 10, 15, 20, and 25).

Statistical analysis

Descriptive statistics, including means, standard deviations, and minimum and maximum values, were calculated for shear bond strength for each of the 4 groups. The 1-way analysis of variance (ANOVA) and the Student t test was applied to determine whether significant differences existed among the groups. Sig-