transmission through these wires. The FRPC archwire, being translucent in nature, allows tooth color transmission, thereby improving esthetics. Aforementioned phenomenon is particularly beneficial in cases where ceramic/tooth colored brackets are used in conjunction with FRPC wires for orthodontic treatment. Moreover, allergic reactions to nickel [18-21], a metallic ion found commonly in contemporary metallic archwires, is averted with the FRPC archwire.

Although, FRPC can offset the unpleasant appearance of the metallic archwires, the frictional characteristics of the wire cannot be overlooked, as friction plays a critical role throughout the course of orthodontic treatment [22,23]. At various stages of orthodontic treatment, the mechanical properties required by the archwire differ; different fiber material, fiber content, and fiber arrangement can modify the mechanical properties of the wire to suit the mechanical requirements of the archwire at various stages of treatment.

Moreover, low friction is one of the optimal desirable properties of an ideal orthodontic archwire [24,25]. The success or failure of fixed appliance orthodontic treatment is greatly influenced by the frictional properties of the materials used and how friction is applied and controlled, in the due course of treatment.

In this study, the friction and wear characteristics of a novel FRPC archwire were evaluated against nickel titanium (NiTi) archwire with various commercially available bracket systems with the following aims and objectives:

1. to determine sliding friction of FRPC archwire with nickel titanium archwire using various archwire-bracket combinations
2. to determine the correlation between surface roughness and friction of the FRPC and NiTi archwires.

Therefore, the null hypothesis tested was that there would be no difference in sliding friction and surface roughness of FRPC archwire and nickel titanium archwires when combined with different bracket systems.

Methods

The 0.018-in. FRPC archwire (Translucent Archwire, BioMers Products LLC) was compared against 0.018-in. NiTi archwire (Super Elastic NiTi, International Orthodontic Services Inc, Houston, TX, USA) (Table 1). The two archwires were tested against four different commercially available brackets having 0.022 × 0.028-in. slot size (Table 2). For the purpose of standardization, only the upper right first premolar brackets having similar torque and angulation with −7° torque and 0° angulation, respectively, were used.

Friction test

The frictional test of each archwire-bracket interface was carried out using a universal testing machine (Model 5848 Micro Tester, Instron Corporation, Norwood, MA, USA). To avoid contamination, all the brackets and wires were cleaned with alcohol swabs before use, and utmost care was exercised during the handling of the same. The test wires were supplied as straight in shape without preformed archwire shapes to avoid trifocal ellipse of the preformed archwires. Stainless steel ligature (PL 1010 Ligature Wire, GAC International, Commack, NY, USA) was twisted until the test wire was firmly secured in the bracket slot and then untwisted three turns to avoid archwire-bracket binding. This was carried out for all the test wire and bracket combinations except for self-ligating brackets. Furthermore, the apparatus was set using a customized jig (Figure 1), such that the bracket traversed 1 mm of test wire at the rate of 0.5 mm/min moving upwards and then downwards for 2 min with each cycle lasting for 4 min with a static load cell ±1 kN (100 kgf, 225 lbf) having 0.025% accuracy (series number S11900, Instron Corporation). A total of 10 cycles were carried out for each test wire and bracket combination, with each test lasting for 40 min. In order to rule out inertia caused by the change in crosshead direction during the last 10 s of each end, only the magnitude of the readings was recorded while discarding the readings obtained at the first and last 10 s of each 2-min cycle.

Five tests were carried out for each bracket and archwire combination. A total of eight archwire and bracket combinations were formed with two archwires and four different brackets. The values of the frictional wear of each archwire-bracket test were captured from the universal

Table 1 Brands, manufacturing companies, configurations, and composition of various brackets used in this study

Brand	Manufacturer	Configuration	Composition
Gemini	3M Unitek, St. Paul, MN, USA	True twin	Stainless steel
Clarity	3M Unitek, St Paul, MN, USA	True twin	Polycrystalline metal-reinforced ceramic
Inspire Ice	Ormco, Orange, CA, USA	True twin	Monocrystalline ceramic
SmartClip	3M Unitek, St Paul, MN, USA	True twin	Stainless steel
		Self-ligating	

True-twin bracket configuration was selected with ceramic and stainless steel composition. The selection of bracket material composition (stainless steel and ceramic (polycrystalline and monocrystalline)) was deliberate in order to encompass brackets with the commonest material composition in this study.