

# Comparative Evaluation of Frictional Resistance of Three Different Types of Passive Self-ligating Ceramic Brackets Using Coated and Uncoated Stainless Steel and Nickel Titanium Arch Wires: An *In Vitro* Study

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## ABSTRACT

**Aim:** The present study was aimed to evaluate and compare the frictional characteristics of three newly introduced passive ceramic self-ligating brackets (SLBs), Damon clear, Truklear, and Cabriolet, using coated and uncoated stainless steel (SS) and nickel titanium (NiTi) archwires.

**Materials and methods:** Fifteen maxillary right central incisor brackets of dimension 0.022" × 0.028" slot: five brackets, each of Damon Clear, Cabriolet, and Truklear brackets. Thirty coated and uncoated SS and NiTi archwires were part of the study.

**Results:** The frictional resistance (FR) with three different passive self-ligating ceramic brackets was studied using three different types of SS and NiTi archwires based on their coating. The Damon Clear bracket showed less FR, while the highest FR was observed for the Truklear bracket when using various types of NiTi archwires; the Truklear bracket showed less FR, while the highest FR was observed for the Cabriolet bracket.

**Conclusion:** FR with three passive SLBs when carried out with the Damon Clear bracket showed less FR, while the Truklear bracket showed the highest FR; and when the study was carried out using NiTi archwire, the Truklear bracket showed less FR, while the Cabriolet bracket demonstrated the highest FR.

**Keywords:** Ceramic, Damon clear, Friction, Self-ligating brackets.

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## INTRODUCTION

Burrow defined friction as the resistance to motion when one object moves tangentially against another.<sup>1</sup> The term self-ligation in orthodontics implies that the orthodontic bracket has the ability to engage the archwire into itself, and is, therefore, assumed to reduce friction by eliminating the ligation force. These bracket systems have a mechanical device built into the bracket to secure the edgewise slot. The two commonly manufactured SLBs are the active SLBs, where they have a spring clip that presses against the archwire, and the passive SLBs where the self-ligating clip just closes the slot, creating a tube, and does not actively press against the wire.<sup>2</sup>

The present study was targeted to evaluate and compare the frictional characteristics of the newly introduced passive self-ligating ceramic brackets, Damon clear (Ormco INC. California), Truklear (Forestadent GmbH, Germany), and Cabriolet (Gestenco International Gothenburg, Sweden) with three different types of coated and uncoated SS and NiTi archwires.

## MATERIALS AND METHODS

In this study, five maxillary right central incisor brackets of dimension and McLaughlin Bennet Trevisi system (MBT) prescription of 0.022" × 0.028" slot were taken from each of the three different groups (Fig. 1):

- Group A: Cabriolet (Gestenco International Gothenburg, Sweden)
- Group B: Truklear (Forestadent GmbH, Germany)
- Group C: Damon clear (Ormco Inc., California)

Each bracket was mounted on an acrylic block using a cyanoacrylate adhesive (Fig. 2). The acrylic blocks were custom made by Matrix Corporation, Govandi (Mumbai). The acrylic blocks

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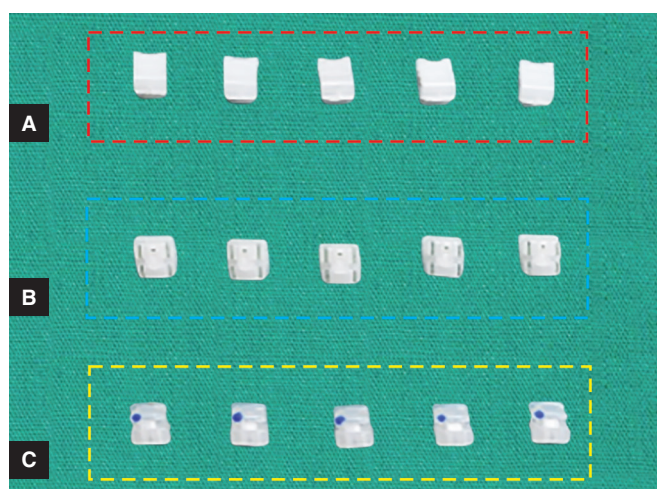
**Source of support:** Nil

**Conflict of interest:** None

offered a flat surface onto which the brackets were fixed. Horizontal and vertical laser markings (Fig. 3) were made on the acrylic blocks to facilitate accurate placement of the brackets. The dimensions of the acrylic block were as follows:

- Height: 70 mm.
- Length: 18 mm.
- Breadth: 18 mm.

While performing each test, new wires were used for evaluating FR. Straight lengths of 0.019" × 0.025" SS wire were cut into pieces of 40 mm in length; 30 such pieces were used for the study (Fig. 4). Each bracket was tested six times using SS uncoated (SSUC) archwire, SS partially coated (SSPC) archwire, SS fully coated (SSFC) archwire, NiTi



Figs 1A to C: (A) Cabroilet; (B) Truklear; (C) Damon clear

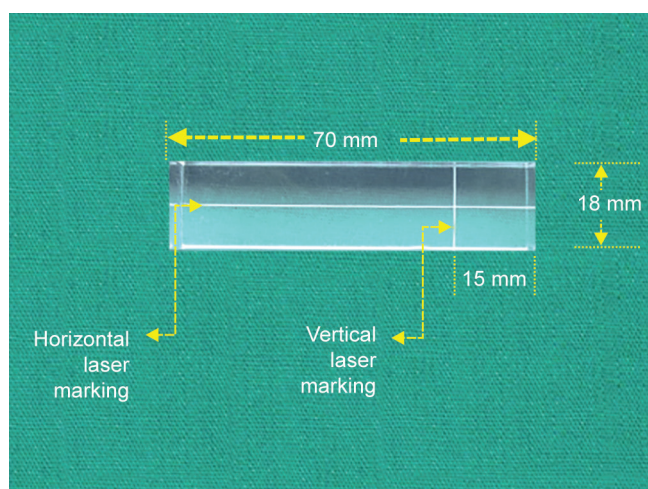


Fig. 2: Acrylic block

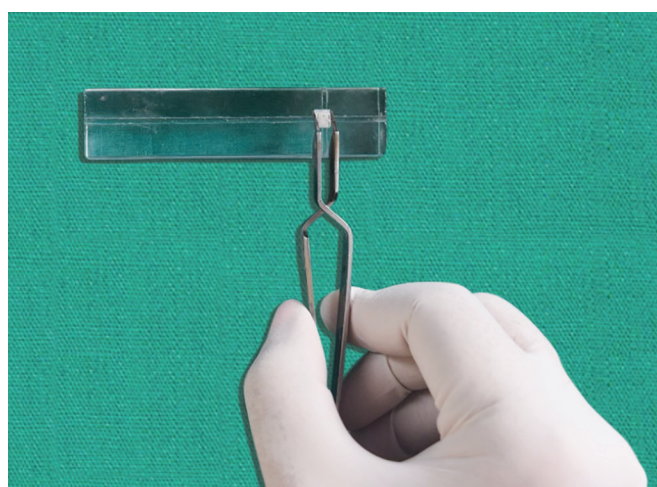
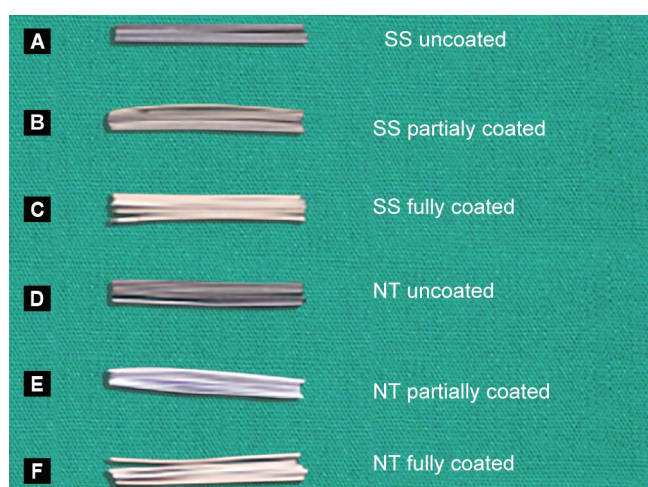


Fig. 3: Fixing bracket on to acrylic block



Figs 4A to F: (A) SS uncoated; (B) SS partially coated; (C) SS fully coated; (D) NT uncoated; (E) NT partially coated; (F) NT fully coated

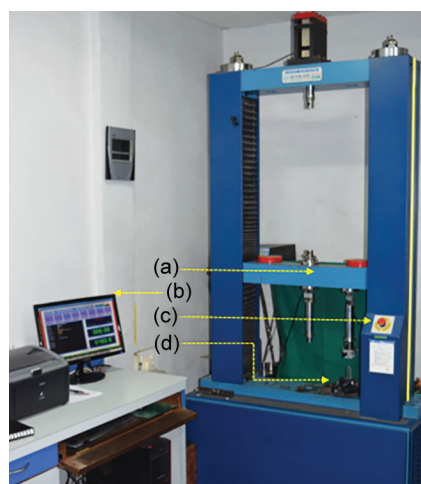


Fig. 5: Parts of universal testing machine, Instron

uncoated (NiTiUC) archwire, NiTi partially coated (NiTiPC) archwire, and NiTi fully coated (NiTiFC) archwire.

The universal Instron testing machine (Fig. 5) was used for measuring FR at the bracket–wire interface. The Instron consists of

two jaws: the upper jaw and the lower jaw. The upper jaw is capable of moving in a vertical direction with a desired speed or force depending on the study design. In the present study, the speed was the criterion used and the force was measured. The lower jaw was rendered to be stationary.

The acrylic blocks were attached to the fixed lower jaw of the Instron machine ensuring that the bracket slot was placed perpendicular to the base of the machine. Straight lengths of wire were fixed to the moving arm (upper jaw) of the testing machine and then fitted in the bracket slot. The rate of movement was prefixed at 3 mm per minute, and each test was carried out for 2 minutes. The peak FR registered was recorded as the static frictional force.

The tests were repeated six times for the same bracket with six different archwires: SSUC, SSPC, SSFC, NiTiUC, NiTiPC, and NiTiFC.

## RESULT

- The Cabroilet bracket when used with all six types of the archwires, it revealed that the mean FR value was the highest for NiTiUC archwire followed by NiTiPC, NiTiFC, SSPC, SSUC, and SSFC archwires.

**Table 1:** Mean FR of each bracket

Bracket type	SSUC	SSPC	SSFC	NiTiUC	NiTiPC	NiTiFC
Cabriolet	0.084	0.104	0.076	0.25	0.242	0.178
Truklear	0.146	0.1	0.128	0.166	0.146	0.096
Damon clear	0.076	0.074	0.084	0.196	0.134	0.096

- The Truklear bracket revealed similar findings that the mean FR value was the highest for NiTiUC archwire followed by NiTiPC, SSUC, SSFC, SSPC, and SSFC archwires.
  - With the use of Damon Clear bracket, the mean FR value was the highest for NiTiUC archwire followed by NiTiPC, NiTiFC, SSUC, SSPC, and SSFC archwires.
- The results of the study are given in Table 1.

## DISCUSSION

SLBs have been gaining popularity in recent years. During the past several decades, interest in SLBs has been rekindled, with the introduction of various types of new self-ligating systems. The reduced friction with SLBs is a primary advantage over conventional brackets.

This present study focused on studying the passive self-ligating ceramic bracket. The researches carried out over the friction produced by different SLBs and wires have a great diversity.<sup>3,4</sup> This is because of the variety of methodologies used. Types of alloys tested from various companies, different brackets, wire combinations, and presence or absence of coating on archwire are some of the variables. All of the aforementioned makes it very difficult to compare the result of these studies.

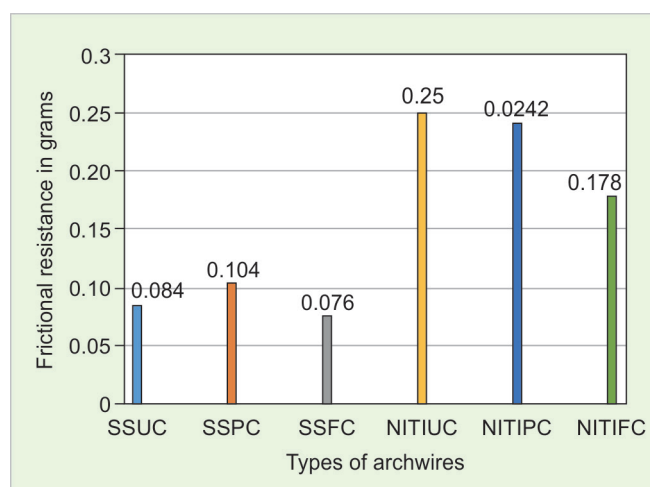
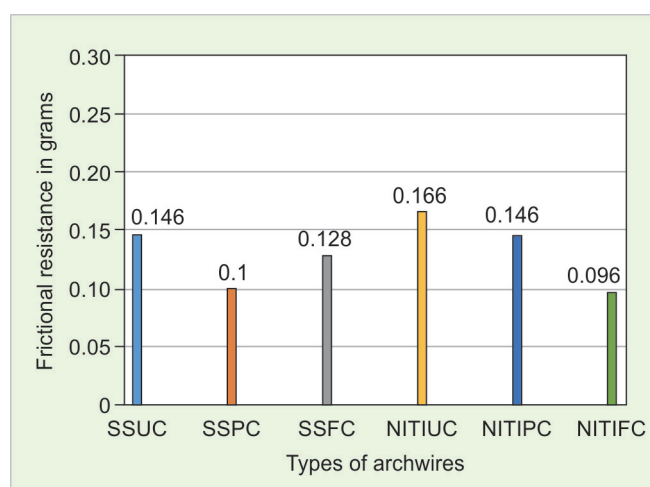
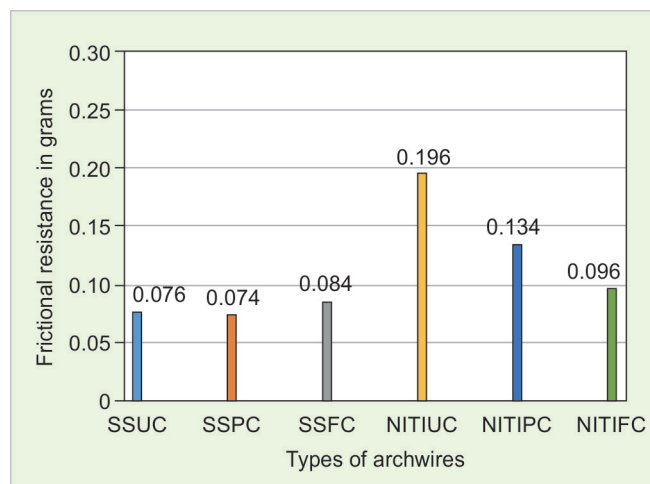
In the present study, frictional characteristics of three newly introduced passive self-ligating ceramic brackets were compared with each other, the brackets used being Damon Clear (Ormco Inc., California), Cabriolet (Gestenco International Gothenburg, Sweden), and Truklear® (Forestadent GmbH, Germany). These brackets were tested for FR. Each bracket was tested six times with SSUC archwire, SSPC archwire, SSFC archwire, NiTiUC archwire, NiTiPC archwire, and NiTiFC archwire. While performing each test, new wires were used for evaluating FR.

When FR with three different passive self-ligating ceramic brackets was studied using various types of SS archwire, the Damon Clear bracket showed less FR, while the highest FR was observed for the Truklear bracket.

When FR with three different passive self-ligating ceramic brackets was studied using various types of NiTi archwires, the Truklear bracket showed less FR, while the highest FR was observed for the Cabriolet bracket.

When the Cabriolet bracket was used with all six types of archwires (Fig. 6), it revealed that the mean FR value was the highest for NiTiUC archwire followed by NiTiPC, NiTiFC, SSPC, SSUC, and SSFC archwires. Similar findings for the Truklear bracket (Fig. 7) revealed that the mean FR value was the highest for NiTiUC archwire followed by NiTiPC, SSUC, SSFC, SSPC, and SSFC archwires. With the use of the Damon Clear (Fig. 8), the mean FR value was the highest for NiTi UC archwire followed by NiTiPC, NiTiFC, SSUC, SSPC, and SSFC archwires.

Studies conducted in the past that tested FR between active and passive SLBs have concluded that passive self-ligating ceramic brackets had less FR compared to the active SLB.<sup>3,4</sup> Krishnan<sup>3</sup> found lower frictional forces for both the passive and active designs than for the conventional brackets and that the passive self-ligating ceramic bracket showed less friction than the active self-ligating ceramic bracket. In an overview of self-ligating ceramic brackets,

**Fig. 6:** FR with group A (Cabriolet)**Fig. 7:** FR with group B (Truklear)**Fig. 8:** FR with group C (Damon Clear)

Maen Zreagat and Rozita Hassan summarized that passive SLBs have a slot depth of 0.028" and, hence, do not exert an active force on the wire ensuring less friction in the appliance during sliding mechanics since the slot provided more room for the archwire and there is no active seating force provided.

Since a perusal of the available literature shows a paucity of studies limited to evaluation and comparison of FR on various passive SLBs, the results of the present study could not be directly compared with other studies.

## CONCLUSION

When FR with three different passive self-ligating ceramic brackets was studied using various types of SS archwire, the Damon Clear bracket showed lesser FR, while the highest FR was observed for Truklear bracket. The FR of the three brackets with various types of NiTi archwires, the Truklear bracket showed lesser FR, while the highest FR was observed for the Cabriolet bracket.

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