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Research

# Comparative Evaluation of Compressive Strength and Film Thickness of a Multifunctional Restorative Material with Established Core Build-Up and Luting Systems: An In Vitro Study

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**Abstract:**
**Background:** Restoration of endodontically treated teeth often requires separate materials for core build-up and luting procedures. ParaCore is widely used by clinicians as a core build-up material because of its favorable mechanical properties, whereas RelyX U200 is a commonly used self-adhesive resin cement for luting procedures due to its optimal handling characteristics and minimal film thickness. Recently introduced multifunctional restorative materials that is Wonder Edge DC by pidilite claim to combine the properties of post cementation, core build-up, and luting into a single material system. However, limited evidence exists regarding their mechanical performance in comparison with established materials. **Aim:** To evaluate the compressive strength of Wonder Edge DC in comparison with ParaCore and to assess and compare the film thickness of Wonder Edge DC and ParaCore in comparison to RelyX U200. **Materials and Methods:** An in vitro experimental study was conducted in which Compressive strength was evaluated for Wonder Edge DC and ParaCore using cylindrical specimens measuring 4 × 6 mm, prepared according to ISO 4049 standards and were tested using a Universal Testing Machine at a cross-head speed of 0.75 mm/min. Film thickness was evaluated for Wonder Edge DC, ParaCore, and RelyX U200 using two optically flat glass plates under a standardized load of 150 ± 2 N under a petrological microscope at 10X magnification. **Results:** ParaCore demonstrated higher compressive strength (136.05 ± 20 MPa) compared with Wonder Edge DC (115.32± 15 MPa). Film thickness values were 15.3 ± 1.8 µm for RelyX U200, 18.4 ± 1.3 µm for ParaCore, and 25.2 ± 2.1 µm for Wonder Edge DC. **Conclusion:** ParaCore demonstrated superior compressive strength, confirming its suitability as a core build-up material. RelyX U200 exhibited the lowest film thickness among the tested materials. Wonder Edge DC demonstrated acceptable mechanical properties and film thickness within ISO limits, suggesting its potential as a multifunctional restorative material.

**Keywords:** Compressive strength, Film thickness, Core build-up materials, Luting cement, ParaCore, RelyX U200.

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**Introduction:**

Restoration of endodontically treated teeth has become an essential aspect of modern restorative dentistry. Advances in endodontic therapy and restorative materials have made it possible to preserve teeth that were previously considered non-restorable. Successful rehabilitation of such teeth requires restoration of the lost coronal structure while maintaining adequate strength and function.[1]

Endodontically treated teeth often exhibit significant loss of coronal tooth structure due to caries, trauma, or extensive previous restorations. This structural compromise can weaken the tooth and reduce its ability to withstand functional forces. As a result, post-and-core systems are commonly used to rebuild the missing tooth structure and provide support for definitive restorations such as crowns.[2]

Core build-up materials are restorative materials used to reconstruct damaged tooth structure prior to crown preparation and to stabilize weakened tooth components. These materials provide the necessary retention and resistance form for indirect restorations and act as a foundation for prosthetic rehabilitation.[3–4]

The success of a core restoration depends largely on the mechanical properties of the core build-up material. An ideal core material should possess adequate strength, dimensional stability, and resistance to occlusal stresses encountered during mastication. Materials that exhibit higher mechanical strength are better able to resist deformation and fracture, distribute functional stresses more evenly, and improve the long-term prognosis of the restored tooth.[3–5]

Mechanical strength of dental restorative materials can be evaluated using various parameters including compressive strength, tensile strength, flexural strength, and shear strength. Each of these properties reflects the ability of a material to resist specific types of stress before failure occurs. In the oral environment, restorations are exposed to complex multidirectional forces generated during mastication and parafunctional activities. Among these mechanical properties, compressive strength is considered one of the most important indicators of clinical performance, because occlusal forces acting on posterior teeth are primarily compressive in nature.[3]

Compressive strength is defined as the ability of a material to resist axially directed compressive forces without fracture or permanent deformation. According to Phillips' Science of Dental Materials, compressive strength represents the capacity of a material to withstand pushing forces and provides information about the relationship between applied load and deformation during testing.[6]

A restorative material with greater compressive strength is therefore more capable of resisting functional stresses and maintaining structural integrity during mastication.

Resin-based composite materials are widely used as core build-up materials because of their favorable mechanical properties, adhesive capability, and ease of manipulation. These materials exhibit high compressive strength, good bonding to tooth structure, and acceptable esthetic characteristics. Additionally, composite core materials set rapidly, allowing crown preparation to be performed shortly after core placement without delay.[5]

Among the currently available core build-up materials, ParaCore is commonly used in clinical practice due to its favorable mechanical properties and dual-cure resin matrix reinforced with filler particles. Previous studies evaluating different core build-up materials have reported that ParaCore demonstrates superior mechanical properties compared with several other composite-based systems.[4]

In addition to mechanical strength, another important physical property influencing the success of indirect restorations is film thickness of the luting material. Film thickness determines how well a restoration seats on the prepared tooth. Excessive cement thickness can prevent complete seating of restorations and lead to marginal discrepancies, microleakage, and long-term failure. According to ADA Specification No. 8, dental luting cements should exhibit minimal film thickness to allow proper adaptation of restorations.RelyX U200, a self-adhesive resin cement, is widely used as a luting agent because of its favorable handling characteristics and low film thickness. At the same time, some core build-up materials such as ParaCore are also claimed by manufacturers to function as luting agents. However, many clinicians primarily use ParaCore as a core build-up material rather than as a luting cement, and its film thickness properties have not been extensively evaluated in comparison with conventional luting materials.

Recently, multifunctional restorative materials have been introduced that claim to combine the functions of post cementation, core build-up, and luting in a single material system. These materials aim to simplify restorative procedures, reduce chairside time, and minimize the need for multiple materials during treatment. However, before such materials can be widely adopted in clinical practice, their mechanical performance must be evaluated and compared with established restorative systems used by clinicians.

Therefore, the present study was undertaken to evaluate the compressive strength of Wonder Edge DC in comparison with ParaCore, a commonly used core build-up material, and to assess the film thickness of Wonder Edge DC and ParaCore in comparison with RelyX U200, a widely used luting cement.

## AIM and OBJECTIVES

1. To evaluate and compare the compressive strength of Wonder Edge DC with ParaCore.
2. To evaluate and compare the film thickness of Wonder Edge DC and ParaCore in comparison with RelyX U200.
3. To assess the potential of multifunctional restorative materials for both core build-up and luting procedures.

## MATERIALS AND METHODS

### Study Design

The present investigation was designed as an in vitro experimental study to evaluate and compare the compressive strength and film thickness of a multifunctional restorative material with established core build-up and luting systems. The study was conducted in accordance with the International Organization for Standardization (ISO) 4049 guidelines for polymer-based restorative materials.[1]

The materials evaluated in the study included Wonder Edge DC, ParaCore, and RelyX U200. ParaCore was selected as a reference core build-up material due to its established mechanical performance, while RelyX U200 was used as a reference luting cement for film thickness evaluation (table 1).

**Table 1- Materials Used**

| Material | Manufacturer | Purpose |
|---|---|---|
| Wonder Edge DC | Wizdent | Multifunctional restorative material |
| ParaCore | Coltene | Reference core build-up material |
| RelyX U200 | 3M ESPE | Reference luting cement |

### Sample Preparation

Separate specimens were prepared for **compressive strength testing** and **film thickness evaluation**.

1. **Sample Preparation for Compressive Strength Testing**

Specimens for compressive strength testing were fabricated using a **stainless steel split mold** with dimensions **4 mm in diameter and 6 mm in height**, as recommended by **ISO 4049 for polymer-based restorative materials**.[1]

A total of **20 cylindrical specimens** were prepared:

- **Group A:** Wonder Edge DC (n = 10)
- **Group B:** ParaCore (n = 10)

Each material was inserted into the mold in **incremental layers of 2 mm thickness**. Every layer was **light-cured for 40 seconds** using a LED curing unit to ensure adequate polymerization.

A **Mylar strip and glass slide** were placed over the final increment to obtain a smooth and uniform specimen surface and to prevent the formation of oxygen inhibition layers.

After fabrication, all specimens were stored in **distilled water at 37°C for 24 hours** prior to mechanical testing in order to simulate oral environmental conditions and allow complete polymerization.

### Compressive Strength Testing

Compressive strength testing was performed using a **Universal Testing Machine (UTM)**. The cylindrical specimens were positioned vertically between the loading plates of the machine.

The load was applied at a **cross-head speed of 0.75 mm/min** until specimen fracture occurred.

The maximum load at fracture was recorded in **Newtons (N)** and the compressive strength was calculated in **megapascals (MPa)** using the formula:

$CS = 4P/\Pi d^2$

Where:

P = Load at fracture (N)

D = Diameter of specimen (mm)

2. **Sample Preparation for Film Thickness Testing**

Film thickness testing was performed for the following materials:

- Group 1 - RelyX U200 (n = 7)
- Group 2 - ParaCore (n = 7)
- Group 3 – Wonder Edge DC (n = 7)

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The procedure was conducted according to **ISO 4049 recommendations for testing luting materials**.[1]

Two **optically flat glass plates** with a surface area of **200 ± 25 mm²** were used for the measurement.

The procedure involved the following steps:

1. The initial thickness of the two glass plates in contact was measured.
2. A standardized quantity of the test material was placed between the glass plates.
3. A vertical load of **150 ± 2 N** was applied to the plates.
4. The combined thickness of the glass plates and the interposed material was measured. Film thickness was determined as the **difference between the two measurements**.

**Film Thickness Measurement**

The thickness measurements were recorded using a petrological microscope at 10× magnification.

The microscope allowed precise visualization of the interface between the glass plates and the interposed material, enabling accurate measurement of the cement film thickness.

**Calibration of the Petrological Microscope**

Prior to the measurements, the petrological microscope was calibrated using a stage micrometer with known scale divisions to ensure measurement accuracy. Calibration was performed by an external certified laboratory, and the microscope scale was adjusted so that the measured divisions corresponded precisely to the known micrometer dimensions.

Calibration procedures for optical microscopes using stage micrometers are widely recommended in materials testing to ensure measurement precision and reproducibility.[3]

## STATISTICAL ANALYSIS

Data were analyzed using **SPSS software (version 25.0)**. The following statistical tests were applied:

- Independent t test (mean and standard deviation)
- One-way ANOVA
- Post-hoc Tukey test

Statistical significance was set at **$p < 0.05$**.

## RESULTS

**Table 2 – Compressive Strength of Tested Materials**

| Material | Mean (MPa) | Standard Deviation |
|---|---|---|
| ParaCore | 136.05 | ±20 |
| Wonder Edge DC | 115.32 | ±15 |

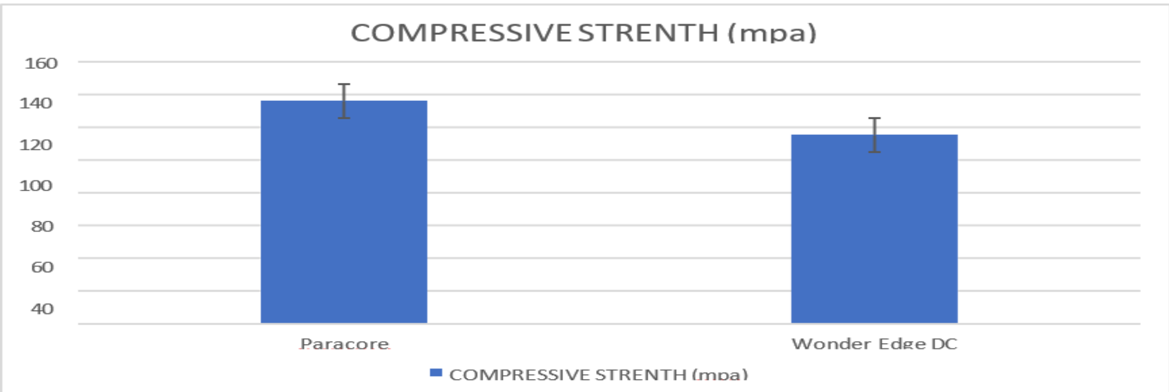
ParaCore demonstrated higher compressive strength compared with Wonder Edge DC.

**Table 3 – Film Thickness of Tested Materials**

| Material | Mean (µm) | Standard Deviation |
|---|---|---|
| RelyX U200 | 15.3 | ±1.8 |
| ParaCore | 18.4 | ±1.3 |
| Wonder Edge DC | 25.2 | ±2.1 |

RelyX U200 demonstrated the lowest film thickness among the tested materials.

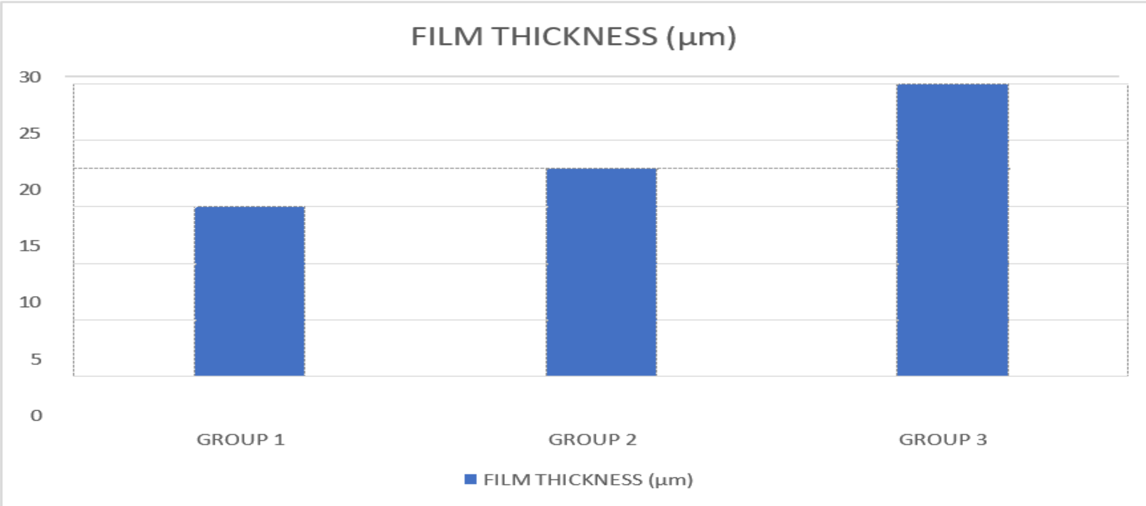
**Graph 1 – Compressive Strength Comparison**




**Observation:** ParaCore demonstrated higher compressive strength.

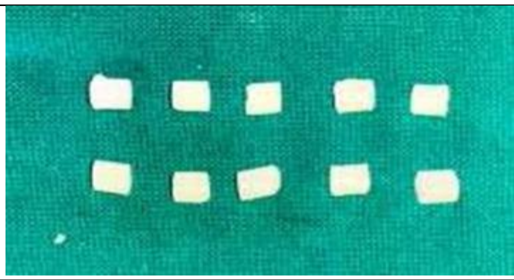
**Graph 2 – Film Thickness Comparison**

Bar graph illustrating film thickness values of:




**Observation:** RelyX U200 showed the lowest film thickness.

**Compressive Strength Testing**

| **Group 1 – ParaCore (figure 1 )** | **Group 2 – Wonder edge DC (figure 2)** |
|---|---|
|  |  |
|  |  |

***Film Thickness Testing***

| ***Group A – RelyX U 200 Figure 3*** | ***Group B – ParaCore Figure 4*** | ***Group C - Wonder edge DC Figure 5*** |
|---|---|---|
|  |  |  |

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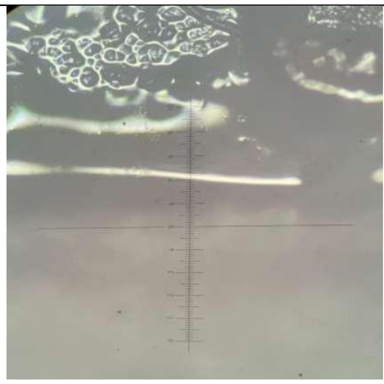
Figure 6 petrological microscope

Figure 7 Compressive strength was determined at a-cross head speed of 0.5mm/min in universal testing machine

***Film Thickness analysis***

| ***Group A – RelyX U 200***<br>***Figure 7*** | ***Group B – ParaCore***<br>***Figure 8*** | ***Group C - Wonder edge DC***<br>***Figure 9*** |
|---|---|---|
|  |  |  |

**DISCUSSION**

The present in-vitro study evaluated the compressive strength and film thickness of a multifunctional restorative material, Wonder Edge DC, in comparison with established materials used for core build-up and luting procedures. The results demonstrated measurable differences between the materials; however, all tested systems exhibited values within clinically acceptable ranges, suggesting potential applicability in restorative procedures.

Compressive strength is considered one of the most important mechanical properties for core build-up materials because restored teeth are subjected to significant compressive forces during mastication. Posterior teeth in particular may experience occlusal loads ranging between approximately 200 and 800 N, and therefore materials used to rebuild lost coronal tooth structure must possess sufficient resistance to compressive stresses to maintain structural integrity during function. According to ISO 4049 guidelines for polymer-based restorative materials, composite restorative materials used for structural applications should demonstrate adequate compressive strength to withstand functional occlusal forces in the oral environment. Resin-based composite core build-up materials reported in the literature typically exhibit compressive strength values ranging from approximately 100 to 300 MPa, which are considered adequate for clinical performance.

In the present study, ParaCore demonstrated higher compressive strength (136.05 ± 20 MPa) compared with Wonder Edge DC (115.32 ± 15 MPa). The higher compressive strength observed in ParaCore may be attributed to its dual-cure resin matrix combined with a high filler loading and optimized filler distribution, which improves resistance to deformation and fracture under compressive loading. Previous studies evaluating resin composite core build-up materials have similarly reported superior mechanical properties for reinforced resin systems with higher filler content, as these materials provide improved stress distribution and structural reinforcement.

Although Wonder Edge DC exhibited lower compressive strength than ParaCore, the values obtained in this study remain within the range commonly reported for resin-based restorative materials. This suggests that Wonder Edge DC still possesses sufficient mechanical strength for several clinical applications. From a clinical perspective, materials with higher compressive strength such as ParaCore may be more suitable in situations involving high occlusal loading, particularly in posterior teeth or cases with extensive loss of coronal tooth structure. In contrast, Wonder Edge DC may be effectively utilized in situations where functional stresses are relatively lower or where adequate remaining tooth structure contributes to load distribution. These situations may include anterior teeth, premolars with moderate structural loss, and post cementation procedures where the primary stresses are adhesive rather than purely compressive in nature.

The comparatively lower compressive strength of Wonder Edge DC may be related to differences in resin matrix composition, filler loading, or filler particle size distribution. Future improvements in the formulation of such multifunctional restorative materials may further enhance their mechanical performance through optimization of filler content, incorporation of nano-hybrid fillers, or increased polymer cross-link density. These modifications could potentially improve resistance to compressive stresses while maintaining the material's multifunctional properties.

In addition to mechanical strength, film thickness is another critical property influencing the clinical success of indirect restorations. Film thickness directly affects the ability of restorations to seat completely on the prepared tooth surface. Excessive cement thickness may prevent proper seating of restorations and can result in marginal discrepancies, occlusal inaccuracies, microleakage, and long-term restoration failure. According to ANSI/ADA Specification No. 8 and international ISO standards for dental luting cements, the film thickness of luting materials should ideally not exceed approximately 25 µm under standardized testing conditions in order to allow proper seating of restorations.

In the present study, RelyX U200 demonstrated the lowest film thickness (15.3 ± 1.8 µm), followed by ParaCore (18.4 ± 1.3 µm), while Wonder Edge DC demonstrated the highest value (25.2 ± 2.1 µm). The low film thickness observed with RelyX U200 is consistent with its formulation as a self-adhesive resin cement specifically designed for luting procedures. Such materials are engineered to exhibit lower viscosity and improved flow characteristics under pressure, allowing restorations to seat accurately with minimal interference. The findings of the present study are consistent with previous investigations reporting favorable film thickness values for resin-based luting cements.

ParaCore demonstrated slightly higher film thickness than RelyX U200 but remained well within acceptable limits. Although ParaCore is primarily used as a core build-up material, manufacturers also indicate its potential use for post cementation procedures. The results of the present study suggest that ParaCore may exhibit acceptable flow characteristics for such applications.

Wonder Edge DC demonstrated a film thickness close to the upper limit recommended by international standards. This observation may be attributed to the multifunctional design of the material. Unlike dedicated luting cements, multifunctional restorative systems must possess sufficient viscosity and structural stability to function effectively as core build-up materials. The higher viscosity required for core reconstruction may contribute to the slightly increased film thickness observed during testing. Despite this difference, the measured film thickness of Wonder Edge DC remains within clinically acceptable limits, suggesting that it should still permit adequate seating of restorations under appropriate clinical conditions.

An additional advantage of multifunctional restorative materials such as Wonder Edge DC is their potential use within the monoblock restorative concept. In post-and-core restorations, the monoblock concept refers to a restorative configuration in which the post, luting material, and core build-up material function as a unified biomechanical unit.[11] Traditional post-core systems require the use of multiple materials, including a separate luting cement for post cementation and a different material for core build-up. The presence of multiple interfaces—such as dentin-cement, cement-post, and cement-core interfaces—may create areas of potential weakness where debonding or failure may occur.[12]

Multifunctional restorative materials allow clinicians to use the same material for post cementation and core build-up, thereby reducing the number of interfacial layers within the restorative complex. When used in conjunction with fiber posts, this configuration is often described as a secondary monoblock system, in which the restorative components behave as a single integrated structure. Such a configuration may improve stress distribution along the tooth-restoration interface and potentially reduce the risk of interfacial failure. In addition to potential biomechanical advantages, the use of a single multifunctional material may simplify clinical procedures, reduce chairside time, and improve material compatibility during restorative treatment.[13-14]

From a clinical standpoint, the findings of the present study suggest that while ParaCore continues to demonstrate superior mechanical strength as a core build-up material and RelyX U200 exhibits the most favorable film thickness for luting procedures, multifunctional materials such as Wonder Edge DC offer a simplified restorative approach with acceptable mechanical and physical properties. The ability to perform post cementation, core build-up, and luting using a single material may provide practical advantages in clinical practice, particularly in situations where simplified protocols and reduced procedural steps are desirable.

Therefore, although Wonder Edge DC demonstrated slightly lower compressive strength and higher film thickness compared with the reference materials, the values obtained in this study remain within acceptable ranges defined by international standards. These findings suggest that Wonder Edge DC may serve as a viable multifunctional restorative material, particularly in clinical situations where moderate functional stresses are expected and simplified restorative protocols are advantageous.

## CONCLUSION

Within the limitations of this in vitro study, the following conclusions may be drawn: ParaCore demonstrated significantly higher compressive strength compared with Wonder Edge DC, confirming its suitability as a conventional core build-up material in situations where higher functional stresses are expected. RelyX U200 exhibited the lowest film thickness among the tested materials, indicating superior flow characteristics and favorable seating behavior for luting procedures.

Wonder Edge DC demonstrated compressive strength and film thickness values that fall within acceptable limits defined by international standards, suggesting that the material possesses adequate mechanical and physical properties for clinical use. Although its compressive strength was lower than that of ParaCore and its film thickness slightly higher than that of RelyX U200, the values obtained indicate that Wonder Edge DC may still function effectively in restorative procedures involving moderate functional stresses.

An important advantage of Wonder Edge DC lies in its multifunctional capability, which allows it to be used for **post cementation as well as core build-up procedures within a single material system**. This approach supports the monoblock restorative concept by reducing the number of interfacial layers within the post–core complex and potentially improving stress distribution while simplifying clinical procedures.

Therefore, multifunctional restorative materials such as Wonder Edge DC may offer a practical alternative to conventional multi-material systems, particularly in clinical situations where simplified restorative protocols and reduced procedural steps are desirable.

Further in vitro and clinical investigations evaluating additional parameters such as bond strength, fatigue resistance, and long-term clinical performance are recommended to better establish the role of such multifunctional restorative materials in restorative dentistry.

## LIMITATIONS

1. The study was conducted under in vitro conditions.
2. Only compressive strength and film thickness were evaluated.
3. Other parameters such as bond strength and fatigue resistance were not assessed.

Further clinical studies are required to evaluate the long-term performance of these materials under intraoral conditions.

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