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CONVENTIONAL VERSUS GUIDED SOCKET-SHIELD TECHNIQUE FOR IMMEDIATE IMPLANT (RANDOMIZED CONTROLLED CLINICAL TRIAL)

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ABSTRACT

INTRODUCTION: Restorative implant treatment is hampered by changes in the alveolar ridge's dimensions after tooth extraction. Due to the disintegration of the periodontal ligament complex surrounding the bundle of bones, Numerous clinical studies have demonstrated that the buccal portion of the ridge contour is more compromised. To avoid the detrimental effects of tooth extraction, several procedures have been developed to preserve the natural ridge dimension. However, these techniques could only partly compensate but not prevent the resorption process. In an attempt to overcome this challenge, the socket-shield technique (SST), based on the root submergence technique (RST) was purposed by Hürzeler et al, 2010, in which a partial buccal root fragment was retained, followed by immediate implant placement.
AIM OF THE STUDY: Comparison between guided and conventional free hand socket shield techniques.
MATERIALS AND METHOD: This was a randomized controlled clinical trial (RCT) in which patients were randomly assigned to two groups: the study group received twelve dental implants in the maxillary esthetic region using guided SST, while the control group received twelve implants using conventional SST. All patients received pre- and post- operative Cone Beam Computed Tomography (CBCT) to assess the accuracy of socket shield preparation in comparison to the actual fragment. Duration of procedure was measured for both groups to compare the techniques.
RESULTS: The guided SST showed better results regarding duration and accuracy, results were statistically significant ($p \leq 0.05$).
CONCLUSION: The guided SST had shown better accuracy and less procedure time when compared with the conventional freehand SST.
KEYWORDS: Alveolar bone preservation, Guided Socket-Shield, Esthetic zone, Buccal tooth fragment, Partial extraction technique.
RUNNING TITLE: Guided socket-shield technique.

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INTRODUCTION

The loss of the periodontal ligament and the ensuing damage, particularly at the buccal bone plate, appear to be responsible for the noticeable changes that occur after tooth extraction. Alveolar bone resorption could make it difficult to put implants, especially in locations where aesthetics is important, like the anterior maxilla. .
This issue has resulted in a demand for buccal hard and soft tissue preservation. Resorption of the buccal bundle bone after tooth extraction can be a serious issue with potentially severe cosmetic consequences (1). The majority of the alveolar bone's blood supply is provided by the periodontium, periosteum, and endosseous marrow of spongy bone. The labial bone of the anterior upper teeth is more prone to resorption following tooth removal because it receives minimal blood flow from the Spongy bone. Following tooth removal, bone remodeling creates a cosmetic difficulty for an implant repair. As a result, grafting treatments are frequently performed with the goal of minimizing bundle bone loss (2).

However, if it is proven that bundle bone can be preserved, these graft treatments may not be required. Investigations show that keeping the tooth root in the alveolar process prevents bundle bone resorption (3). The root retention concept was expanded to oral implantation by Parlar and colleagues in 2005 by inserting an implant in a chamber in the middle of a tooth socket. These implants, however, failed due to osseointegration failure, with connective tissue developing into the gap between the implant and the dentinal wall. Hürzeler et al developed the SST in 2010, while Gluckman et al advocated vertically sectioning the root and cutting it mesio-distally into the buccal and palatal sections in 2017. The socket-shield approach, which aims to conserve rather than compensate, has proved successful for implant placement in the aesthetic zone (4).

The SST relies on precise preparation of the tooth fragment and implant placement to be successful. A full-thickness flap, especially in the aesthetic zone, is not indicated in this method, mainly to reduce tissue recession and bone resorption resulting from surgical trauma and cutting off the blood flow (5).

The technique is somewhat challenging regarding both the preparation of the root fragment and the placement of the dental implant. Furthermore, the conventional free-hand SST combined with implant placement is more difficult and time-consuming than immediate implant placement alone (6).

Several modifications and classifications have been developed for the SST in order to aid in understanding the preparation design and the role of shield and maximizing its usage to achieve best possible esthetics in immediate implant placement sites. Kumar and Kher have provided a classification of six types of shields based on their intended design and function in treatment planning. These are : These are multiple buccal, lingual (palatal), interproximal, half C buccal, full C buccal, and buccal ones (7).

Clinical investigations have shown that keeping the roots of hopeless teeth may aid to prevent tissue changes after tooth extraction. As a result, the goal of this proof-of-concept study was to evaluate the accuracy and procedure duration of the guided SST in comparison with the conventional free hand SST. (8).

This study's primary objective was to evaluate the accuracy of the preparation of the guided SST “along the whole length of the root”.

The secondary goal was to evaluate the duration of the procedure of the SST.

MATERIALS AND METHODS

MATERIALS:

- Dental Implant system.[1]
- High-speed handpiece.[2]
- 3-D printed Resin Guide.[3]
- Cone beam computed tomography (CBCT) scans.[4]
- Extra-long-shank fissure carbide bur.[5]
- Local Anesthesia.[6]
- Periotome.[7]
- Surgical Curette.[8]

METHODS:

Informed consent:

The Faculty of Dentistry at Alexandria University's research ethics committee approved the study before it was started. All patients were given information on the procedure performed before being enrolled in the experiment, and each participant gave a written consent. Each patient was also told that there would be no consequences if he or she left the study at any time.

Study Design: This was a RCT involving two groups (control group and study group) with 1:1 allocation ratio. The study was reported according to the CONSORT guidelines, and was approved by the committee.

Settings and location: Twenty-four participants were chosen from the oral and maxillofacial surgery department's outpatient clinic at Alexandria University's faculty of dentistry, Egypt. In which the surgical procedure was done at the minor oral surgery clinic of the same place.

The study group: Twelve Maxillary teeth in the esthetic region (4 central-incisors, 3 Lateral-incisors, 3 canines, and 2 premolars) were removed, then immediately implanted (V-line, Vitronex implant system, Italy) utilizing the guided SST.

While the control group: Twelve Maxillary teeth in the esthetic region (3 lateral-incisors, 4 canines and 5 premolars) were also removed and followed by immediate implant placement as the study group but in this group the conventional freehand SST was utilized.

The inclusion criteria for the case selection were patients requiring dental implants, patients with hopeless remaining root in the maxillary aesthetic area (centrals, laterals, canines, and single rooted premolars), adequate bone height (allow for at least 3mm apical to the base of the socket in order to achieve acceptable primary stability) and width (6-9 mm), age range between 18 – 50 years old, good oral hygiene and Abundant keratinized mucosa.

[1] V-line,Vitronex implant system, Italy.

[2] Coxo Highspeed.

[3] Dental yellow clear, Harzlabs, Russia.

[4] Planmeca Promax 3D, Planmeca, Finland.

[5] Komet Dental, Germany.

[6] Articaine 4% 1:100,000 epinephrine; Artinibsa 40 mg/0.1 mg/mL—epinephrine 1:100.000, Spain.

[7] PERIOTOME P1, GDC Fine Crafted Dental Pvt. Ltd, Pakistan

[8] SURGICAL CURETTE LUCAS #CL85 #4, GDC Fine Crafted Dental Pvt. Ltd, Pakistan

Regarding the exclusion criteria, it included patients with uncontrolled systemic diseases, parafunctional habits, unresolved infection in implant site, poor oral hygiene and bone resorption especially in the buccal plate of bone.

Pre-surgical Phase

Scaling and root planning were performed with recommendations for implementing proper oral hygiene. Every patient underwent a clinical and radiographic examination, and a detailed history was recorded that included details about their personal and medical histories as well as their dental history. To achieve optimal patient recruitment, a local visual examination and palpation of the entire oral and para-oral tissues were performed. (INR, HbA1c and CBC). Mouthwash and strict oral hygiene instructions were prescribed for each patient. An alginate primary impression (Cavex cream alginate normal set, Netherlands) and a preoperative CBCT and intraoral scan of the whole dentition were obtained and superimposed. To correctly prepare the remaining root and place the implant, two distinct guidance templates were constructed.. The shield surgical guide was created using a software application (Bluesky Plan, BlueskyBio, USA), for precise residual root preparation, and the other surgical template was produced for the implant (V-line, Vitronex implant system, Italy). The socket-shield guide was designed in the same way as a traditional guide that is fabricated by a software and then printed, and it also relies on the neighboring dentition for retention.

Surgical Phase

In the study group, the first surgical guide that was designed to prepare the retained root was placed and the preparation procedure was executed using a highspeed air-driven dental handpiece under profuse saline irrigation, the labial root fragment was detached from the rest of the retained root using an Extra-long-shank carbide bur (Bone cutter H162SXL.314.014; Komet Dental) in gentle mesio-distal in a sweeping like motion from the margin of the gingiva to the apex of the root following the slot of the surgical guide, with the aim of separating the labial segment from the palatal segment without violating the integrity of the labial portion.

The periodontal ligaments were then severed by inserting a fine periotome between the palatal root part that will be extracted and the palatal alveolar plate. The divided palatal tooth remnant was then cautiously removed without disrupting the labial shard. Tungsten carbide round bur (bur 197; Mani) was used to refine the remaining tooth shard to 1.0 mm above the alveolar bone level. Following cautious pruning in a mesio-distal and apical-coronal directions with a long-shanked round diamond bur that sculpted the internal surface of the shield contour to be concave, the coronal section of the labial section was approximately at the crest level. The second surgical template was then used to drill the osteotomy for the implant, drilling the socket was done with the manufacturer's recommended drills (Guided surgical kit, B and B, Italy). In order to gain stability, drilling of 3 to 5 mm apical to the socket was done. After that, the implant was inserted (V-line,Vitronex implant system, Italy) and customized healing abutment was placed. **Figure (1-4)**

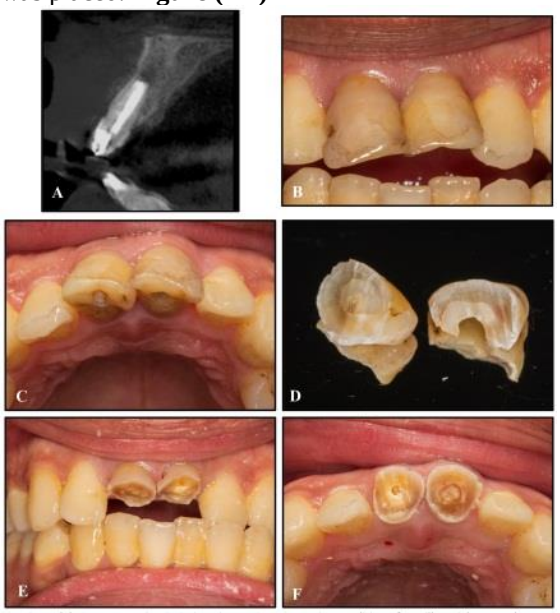

Figure (1): A, Preoperative CBCT imaging. **B, C,** Preoperative condition of maxillary right central incisor. **D, E, F** decapitation of tooth.

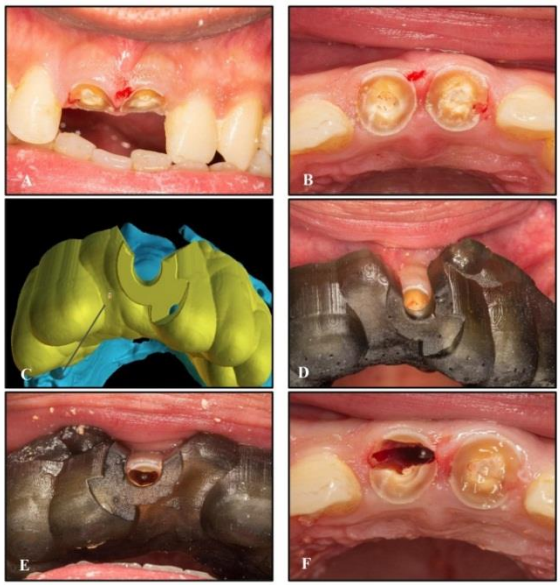

Figure (2): A, B, Coronal reduction to gingival level. **C,** preparation template of shield guide seating verification windows incorporated in the guide design. **D,** clinically seated guide. **E,** Root was divided, and the socket shield was prepared using the preparation template's trajectory. **F,** Occlusal view of the separation of the buccal and palatal segments.

In the control group: utilizing a high-speed handpiece while being profusely irrigated.

Using the same bur, the palatal segment were aimed to be separated from the rest of the root without violating the integrity of the labial part by gently utilizing a sweep like motion mesiodistally from the margin of the gingiva to the root apical area (conventional SST).
The palatal fragment was then removed and preparing the shield was executed as previously explained in the study group.
To compare the guided SST and the traditional free-hand SST, the length of the procedure for both groups was measured from the beginning of shield preparation until the implant insertion.
Implant stability was assessed during implant insertion using insertion torque and after implant insertion completion, a smart peg was attached and the ISQ value was measured (Osstell ISQ, W and H Company Bürmoos, Austria).

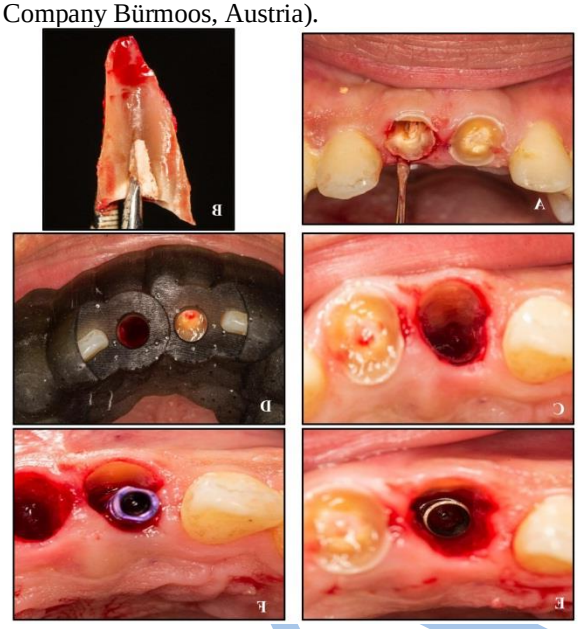

Figure (3): A, B palatal segment removed using periotome. **C,** prepared shield. **D,** Implant guide seated with verification windows incorporated in the design. **E,** implant inserted in place. **F,** Temporary abutment was inserted.

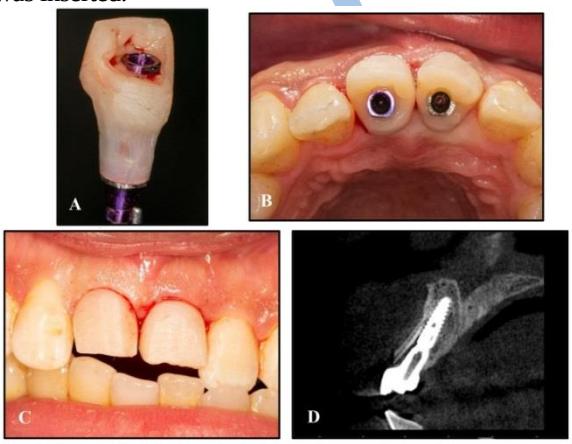

Figure (4): A, B, C Fabrication, contouring, and polishing were done outside the patient's mouth on a temporary abutment with a composite filler manufactured crown for easy adjustment and alteration. **D**, Postoperative CBCT imaging of socket shield and implant.

Postoperative phase

On the first day, all patients were advised to apply cold packs orally extra almost every 10 minutes for an hour. Postoperative medications were prescribed including 1 gm Amoxicillin-Clavulanic acid every 12 hours for 5 days and 400 mg ibuprofen every 6 hours for 3 days when needed.
The patients regularly rinsed their mouths with chlorhexidine 0.2% mouthwash and adhered to strict oral hygiene protocols (Orovex mouthwash, Macro group, Egypt) for 2 weeks.
Accuracy was measured by superimposing the 3D model of the treatment plan with the 3D model of the actual result using 3-matic software (Mimics innovation suite 21.0, Materialize, Belgium).

Follow-up phase

Early follow-up (1-2 weeks): On a regular basis for a week, postoperative pain was measured using a 10-point Visual Analogue Scale (VAS) (0-1= None, 2-4= Mild, 5-7= Moderate, 8-10= Severe).
Late follow-up (1,2 and 3 months) Probing depth, infection, pain and bleeding on probing were assessed. Secondary stability was measured after 3 months of implant placement using Osstell (osstell ISQ W and H Company Bürmoos, Austria).
Radiographic evaluation: Cone Beam Computed Tomography (CBCT) (Planmeca Promax 3D, Planmeca, Finland) was taken twice, pre- and post-operative to compare between planned implant position and the actual post-operative implant position, and compare the planned "shield" labial fragment with the actual post-operative fragment
Prosthetic phase: Final prosthetic treatment was performed after 6 months using screw-retained zirconia crown.
Statistical analysis:
The IBM SPSS version 20.0 software was utilized to input and analyze the data. Qualitative data was described using numbers and percentages, while the Shapiro-Wilk test was used to check for normal distribution of the quantitative data. The data was further characterized using measures such as the range, mean, standard deviation, median, and interquartile range (IQR). Results were considered statistically significant at a 5% level.

RESULTS

Twenty-four patients with a mean age of 37 years were included in this study, all cases were successfully osseointegrated. Regarding the accuracy of the superimposition of the predicted 3D model of the shield and the postoperative 3D model of the actual shield for each case, the mean difference in the study group was 0.24 ± 0.05, and in the control group was 0.39 ± 0.12.
The difference between the two means was confirmed to be statistically significant with independent samples t-test ($p \leq 0.05$). Table (1)

Regarding the procedure duration, the mean of the study group was 103.25 ± 6.85, while the mean of the control group was 120.58 ± 6.20 in lights of that, the difference between the two means was found to be statistically significant with independent samples t-test ($p \leq 0.05$). **Table (2)**

In terms of the implant stability, the mean difference of the study group was 60.58 ± 4.25, while for the control group was 60.92 ± 4.83. The difference between the two means was found to be statistically negligible with independent samples t-test ($p \leq 0.05$). Table (3)

Surgical Guide wearing out was noticed in one of the cases and it was caused by the friction of the shank of the bur with the guide.

Table (1): Comparison between the two studied groups according to mean in shield preparation accuracy

	Study (n = 12)	Control (n = 12)	t	p
Mean				
Min. – Max.	0.16 – 0.33	0.21 – 0.59		
Mean ± SD.	0.24 ± 0.05	0.39 ± 0.12	3.779*	0.002*
Median (IQR)	0.23 (0.21 – 0.28)	0.39 (0.28 – 0.50)		

IQR: Inter quartile range SD: Standard deviation t: Student t-test
p: p value for comparing between the two studied groups
*: Statistically significant at $p \leq 0.05$

Table (2): Comparison between the two studied groups according to time\minute regarding shield preparation

	Study (n = 12)	Control (n = 12)	t	p
Time\minute120.5				
Min. – Max.	90.0 – 112.0	109.0 – 130.0		
Mean ± SD.	103.25 ± 6.85	120.58 ± 6.20	6.498*	<0.001*
Median (IQR)	104.0 (99.0 – 109.5)	120.50 (116.0 – 125.5)		

IQR: Inter quartile range SD: Standard deviation t: Student t-test
p: p value for comparing between the two studied groups
*: Statistically significant at $p \leq 0.05$

Table (3): Comparison between the two studied groups according to implant Stability ISQ

Stability ISQ	Study (n = 12)	Control (n = 12)	t	p
Min. – Max.	56.0 – 68.0	54.0 – 70.0		
Mean ± SD.	60.58 ± 4.25	60.92 ± 4.83	0.179	0.859
Median (IQR)	59.50 (57.0 – 64.0)	59.50 (57.5 – 63.5)		

IQR: Inter quartile range SD: Standard deviation t: Student t-test
p: p value for comparing between the two studied groups
*: Statistically significant at $p \leq 0.05$

DISCUSSION

The main goal of this study was to evaluate the accuracy of the preparation of the guided SST "along the whole length of the root" and to measure the duration of this procedure in comparison with the conventional freehand SST.

Our technique solidifies that it is possible to establish osseointegration with buccal root retention and immediate implant insertion without inducing an inflammatory or resorptional reaction. and this coincides with Hürzeler et al. (9), however, all partial extraction methods call for total infection clearance by thorough curettage using small size surgical curette and frequent irrigation with normal saline, which is consistent with earlier research by Gluckman et al. that highlights the significance of eliminating any inflammatory tissue. (10-12).

Additionally, the retained root part seems to have maintained its properties, especially in terms of its supra-periosteal attachment and periodontal ligament. This can be observed in consonance with studies evaluating submerged roots usage to enhance the overdentures retention and stability. 16 mandibular premolar roots in four dogs that had undergone endodontic treatment were the subject of a study by O'Neal et al. in 1978. Results after 1-4 months revealed limited peri-coronal inflammation, no periapical inflammation, and coronal overgrowth of bone O'Neal et al. 1978 (13).

In contrast to the research previously mentioned, only the labial portion of the remaining root and its supra-periosteal connection were retained in this study, and no primary closure was also attained.

In this study, we used the exact surgical and prosthetic protocol to compare two surgical techniques in terms of accuracy and duration (Guided SST and conventional free-hand SST).

The guided socket shield technique has shown significant difference in terms of procedure duration. Regarding shield preparation, the usage of the 3D printed guide has been shown to be useful and increased the accuracy of the shield preparation procedure and this was with agreement with Chen et al. (14).

Photopolymerizing resin preparation template has some drawbacks, including the possibility of wearing out and tearing during preparation and this was with coincidence with Chen et al. (14) who used CAD-CAM titanium preparation template to avoid this disadvantage. In our study one of the cases encountered guide wearing out and it was disfigured, due to excessive pressure by the bur on the guide.

When issues of resorption of bone and infection were documented after implants were placed in contact with undetected remaining root sections at the time of extraction, the possibility that the SST may pose a threat of infection to implants placed close by has lately been proposed. (15).

The root sections that were left in place showed no evidence of resorption during the course of the current study, but other researchers have noted this phenomenon in previous experiments; it resolved on its own without impairing implant recovery success rate (16).

One of the noticed disadvantages of the SST we found is the technique's lack of a set methodology. However, some assert that the root shard should be at the same level as the buccal alveolar ridge in order to decrease the vulnerability of the root to fracture. Few references mention the width and length of the remaining root shard in the SST. (17).

Others, however, believe that in order to protect more of the periodontal ligament and potentially retain soft tissue, the root should be at least 1 mm above the alveolar ridge. It is evident that SST reported overwhelmingly positive results whereas very few other publications had a sizable number of drawbacks and issues. This shows that the socket-shield approach could be method-dependent. (18).

None of the implants inserted during this trial failed. All twenty-four immediate implants were properly osseointegrated, with a 100% success rate and appropriate healing of the surrounding soft tissue. According to Gluckman et al. (19) who reported a success rate of 96.1% and Siormpas et al. (20) who also reported a high success rate of 98%, this was parallel to our results.

Our study found no statistically remarkable difference in implant stability between the two groups. On the other hand, both groups' ISQ values increased statistically significantly across the follow-up periods. This was consistent with the findings of Abd-Elrahman et al. (21) who discovered that after 6 months, neither the study group nor the control group's mean ISQ substantially differed from one another.

Furthermore, Barakat et al. (22) showed a substantial improvement in implant stability between the time of surgery and a 4-month follow up period when they tested immediate implantation with SST.

The soft tissue of every patient in our investigation was in good health, which was consistent with the findings of Bäumer et al. (23) who reported outstanding soft tissue healing with SST and healthy prerequisites were found by peri-implant probing.

However, according to Gharpure et al. (24), the SST is linked to a number of different problems, including deep probing pockets, an increased risk of implant exposure, recession of gum, infection, and atrophy of crestal bone.

Graft material must always be employed, according to Gluckman et al. (19), to fill the space between the implant and the buccal section of the root fragment.

To further slowdown bone resorption, Habashneh et al. (25) and Bramanti et al. (26) advise putting a heterologous graft material in the empty space.

Siormpas et al. (20) implemented that there is no need for grafting the aperture between the remaining buccal root shard and the implant, which is consistent with our investigation where there was no graft material was added in the gap between the labial shield and the implant and all cases in the follow up expressed osseointegration and bone development between the implant and the labial shield fragment.

Recent histological studies demonstrated that bone formation occurred in the area between the dentin shield fragment and the implant without the use of biomaterials lend weight to this idea (27).

CONCLUSION

Based on the results of our research, the guided socket shield technique was found to be more advantageous than the conventional freehand technique regarding the duration and accuracy of the procedure.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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