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Comparative Study of Using DASK System versus Trephine Bur SLA in Lateral Sinus Lifting Window Approach with Simultaneous Implant Placement

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Abstract: We introduce a comparative study of two surgical kits for the lateral approach of maxillary sinus lifting using a conventional Dentium Advanced Sinus Kit (DASK) system versus a Sinus Lateral Approach (SLA) trephine bur. This study aims to clinically and radiographically evaluate and compare the effectiveness of using a conventional DASK system versus an SLA trephine bur in the lateral window approach of sinus lifting with simultaneous implant placement. The clinical study was conducted in 2023 on twenty patients indicated for open sinus lifting procedures. Patients were divided into two groups: the conventional group was treated using DASK trephine bur group was treated using the Sinus Lateral Kit (SLK). Radiographic Assessment included measurements of changes in bone heights and bone gains formed buccally and palatally around the implant on cross-sectional cuts

of cone beam computed tomography (CBCT), incidence of membrane perforation, and duration of surgery. Data were collected and statistically analyzed using IBM SPSS Statistics version 23 for Windows 10. The SLA trephine group showed a lower perforation rate and reduced surgical time than the conventional group, with statistical significance difference. A statistically non-significant difference was observed in implant stability and bone density between the two groups. Conclusion: The use of trephine drills in the SLA system allows better access to the lateral approach and minimizes the risk of sinus membrane perforation and operative time during osteotomy compared with conventional DASK drills**.**

Keywords: Dentium Advanced Sinus Kit; conventional Dentium Advanced Sinus Kit system; sinus lateral approach; sinus lateral approach trephine bur; Schneiderian membrane perforation; lateral sinus lifting

DASK系统与环钻SLA在侧窦提升开窗入路同期植入种植体中的比较研究

摘要：我们介绍了一项比较研究，研究了两种用于上颌窦提升侧入路的手术套件，一种是使用传统的登腾高级鼻窦套件(DASK)系统，另一种是使用鼻窦侧入路(SLA)环钻。本研究旨在从临床和放射学角度评估和比较在侧窗入路鼻窦提升和同时植入种植体中使用传统DASK系统与SLA环钻的有效性。这项临床研究于2023年对20名适合进行开放式鼻窦提升手术的患者进行。患者分为两组：常规组使用DASK环钻治疗，组使用鼻窦侧入路套件(SLK)治疗。放射学评估包括测量锥形束计算机断层扫描(CBCT)横切面上种植体周围颊侧和腭侧骨高度和骨增益的变化、膜穿孔的发生率和手术持续时间。使用适用于视窗10的IBM SPSS统计版本23收集和统计分析数据。SLA环钻组的穿孔率低于传统组，手术时间缩短，具有统计学意义。两组之间的种植体稳定性和骨密度差异不显著。结论：与传统的DASK钻相比，在SLA系统中使用环钻可以更好地进入侧入路，并最大限度地降低截骨术中窦膜穿孔的风险和手术时间。

关键词：登腾高级鼻窦套件；常规登腾高级鼻窦套件系统；窦侧入路；窦侧入路环钻；施奈德利安膜穿孔；侧窦提升

1. Introduction

Over time, the maxillary sinus undergoes a process called pneumatization, which occurs when an individual loses their posterior maxillary teeth, enlarges the maxillary sinus, and encompasses a larger portion of the posterior maxillary alveolus. Over time, the alveolar bone of the posterior maxilla will undergo resorption. Pneumatization of the maxillary sinus and resorption of the maxillary alveolar bone result in difficulty in placing dental implants in the maxillary sinus area [1].

Lateral Sinus Lifting is one of the most widely used augmentation procedures for increasing the vertically available bone volume of the edentulous posterior maxilla, where the bone is often of poor quality and is reduced by the extended maxillary sinus [2].

The main intraoperative complication of sinus lifting with the rotary technique is perforation of the Schneiderian membrane, which is observed in 10-35% of all such operations and usually occurs in the osteotomy drilling phase while preparing the window for access to the sinus [3, 4].

Currently, there are special kits for a minimally invasive technique of lateral sinus lifting, and DASK (DENTIUM CO LTD, Seoul, South Korea) has been introduced as a conventional rotary technique to prepare a lateral sinus window for sinus lifting through the antrostomy (thin-out) approach using light pressure and rotating strokes [5, 6].

To reduce the risk of perforating Schneider's membrane, a recently introduced SLA trephine drill (Neobiotec, Seoul, South Korea) has a special design, using a guide drill to start the window and obtain the correct position to avoid slipping, after which other drills in the kit were used [7].

The present study was designed to compare the intraoperative and postoperative performance of the conventional DASK system versus trephine bur SLA in sinus lift, analyzing sinus membrane perforation in direct maxillary sinus lift with both techniques, and analyzing the bone gain obtained after sinus augmentation based on cone beam computed

tomography (CBCT) scans.

2. Patients and Methods

2.1. Study Setting and Population

A clinical study was conducted on twenty patients with 40 implants (twelve females and eight males) who required implant treatment in the maxillary premolar or molar area. The patients were selected from the outpatient clinic of the Oral and Maxillofacial Surgery Department, Faculty of Dental Medicine, Assiut Branch, Al-Azhar University. Their ages ranged from to 20-55 years. All patients were informed of the study and signed a consent form. Ethical approval was obtained from the Faculty of Dental Medicine, Assiut Branch, and the Al-Azhar University ethical committee. This study adhered to the declaration of Helsinki on medical protocols and ethics.

2.2. Inclusion Criteria

Patients requiring unilateral or bilateral sinus lifting with residual alveolar bone height of 5-8 mm.

2.3. Exclusion Criteria

Patients with acute inflammation of the maxillary sinus, alcohol, drug abuse, heavy smoking, radiotherapy or chemotherapy, parafunctional habits, uncontrolled systemic disease, or pregnant patients.

2.4. Grouping and Intervention

Patients selected in this study were classified into two equal groups using online randomization software. The conventional Group (G I): The lateral sinus approach with simultaneous implant placement was performed using the conventional DASK system in ten patients (six females and four males). SLA trephine group (G II): The lateral sinus approach with simultaneous implant placement was performed using the SLA kit in ten patients (six females and four males).

2.5. Preoperative Evaluation

Past and present dental histories were taken thorough clinical examination, and radiographic evaluation was performed on all patients to be included in the study.

2.6. Surgical Procedure

Prior to surgery, the patient was instructed to rinse his mouth for about 1 minute with Chlorhexidine Gluconate 0.12% mouth wash followed by circumoral scrubbing with gauze soaked in Povidone-Iodine solution 10%. Local anesthesia was performed using articaine hydrochloride and epinephrine (adrenaline) 1:100,000 (Artinibsa, Inibsa, Barcelona, Spain).

2.6.1. Surgical Flap Exposure

The lateral wall of the sinus was exposed by performing a crestal incision with an anterior vertical releasing incision, and the full mucoperiosteal flap was carefully reflected to expose the lateral wall of the maxillary sinus.

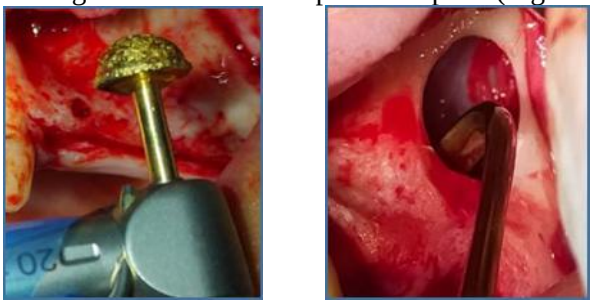
2.6.2. Surgical Techniques

Group I: lateral window technique for maxillary sinus elevation using conventional DASK system

A bony window (thin out) technique was created using a DASK drill #4 or #5 at 800:1200rpm,30:40 N.CM with external irrigation the DASK drill was moved mesially distally with gentle pressure until the proper shape and size of the bony window was achieved. When a dark shadow of the sinus membrane appeared, the sinus was carefully elevated. Next, the sinus membrane was detached using a dome-shaped sinus membrane elevator (XSE1L) and elevated using an elevator (XSE4L) to create adequate space for graft material in a careful manner to avoid perforation of the sinus membrane. However, in cases of perforation, a resorbable collagen membrane (Collagen AT; Sistema At, Italy) was placed just below the perforation.

Group II: lateral maxillary sinus floor elevation using a trephine bur SLA

Full mucoperiosteal flap was carefully reflected to expose the lateral wall of the sinus as pervious mentioned in Group I. A bony window (wall off) technique was created using Sinus Lateral Approach (SLA kit Neobiotech Co) by using C-Guide. The C-Guide was used as a guide drill to prevent slippage and to locate the position accurately before use of the C-Reamer. Next the C-Reamer was mounted on contra angle hand piece (1:20) 2,000 rpm with external irrigation to create a circular core while forming a bone window in the lateral wall. The bony core was detached from the membrane by sinus membrane elevator and stored in gauze to be used as a cover after the procedure. Next; elevator 1 was used to initially remove the mesial and the distal membranes immediately after formation of the hole, next elevator 2 used to detach the lower part of the lateral wall from the hole. Finally, elevator 3 was used to detach any remaining tissue from the deep interior parts (Figure 1).



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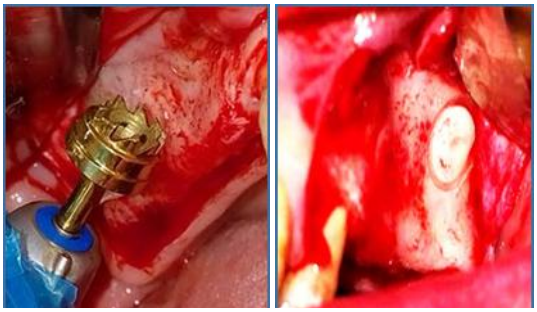

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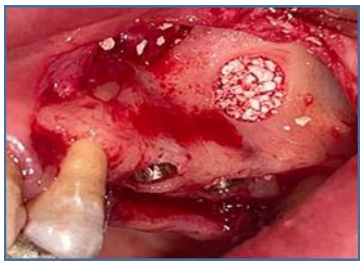

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Figure 1. Lateral maxillary sinus floor elevation using a trephine bur SLA: (A) diamond-studded bur from the DASK system (drill#5 of 8.0-mm diameter); (B) using of sinus elevator (XSE1L) to lift the membrane; (C) C-reamer of 6.5 mm in diameter and 3 mm in length; (D) the bone core created by C-reamer drill; (E) filling the lifting space with bone graft and implant in its osteotomy site (The authors' elaboration)

2.6.3. Packing of Bone Grafting Material and Implant Installation

The bovine bone graft (BIOGAP®, particle size~1.0-2.0 mm KONEKTBIOPHARM, Russia) was used as a standard graft material that was packed gently into the sinus, and implant osteotomy sites were prepared with graduated bone drills of sequential diameters. Finally, implants (Neobiotech® Co., Ltd., Korea) were inserted into the osteotomy sites using a torque-wrench in a self-tapping fashion for primary stability. In Group II, the bone core was repositioned to its original site to cover the prepared window and grafting material.

2.6.4. Flap Repositioning and Closure

The flap was repositioned in its place, and soft tissue was closed over the implant using 3-0 non-resorbable suture.

2.7. Postoperative Care and Instructions

Postoperative instructions should be taken in the immediate postoperative period to minimize contact with the implants, and patients may want to limit foods to softer items and chew in an area away from the implants, clean their mouth thoroughly after each meal beginning the day after surgery, use a soft bristle toothbrush and toothpaste after meals and at bedtime, and not rinse their mouth the day of surgery.

2.8. Postoperative Evaluation

2.8.1. Clinical Evaluation

Evaluation of the incidence of membrane perforations and operative time, the duration of the surgical procedure was documented and recorded for each surgical procedure in minutes (min) from the incision to suturing; clinical follow-up will be performed immediately postoperatively and later at 6 months for stability, complications, any signs of swelling or infection, and assessment of initial stability using the Osstell device immediately post-operatively after implant insertion, and second stage surgery after 6 months postoperatively to evaluate secondary stability using the Osstell device.

2.8.2. Radiographic Evaluation

1) Ridge height: The ridge height was measured from postoperative CBCT images showing the vertical distance from the cortical bone under the floor of the maxillary sinus to the alveolar bone crest in millimeters (mm).

2) Bone gain: These measurements were performed on the buccal and palatal surfaces of the implant in a cross-sectional cut parallel to the long axis of the implant. From the immediate postoperative CBCT and 6 months postoperative CBCT, a cross section was taken coinciding with the long axis of each implant, and the distance between the bony crest and the newly formed sinus floor was measured along the surface of the implant. The values of the native bone height were subtracted from those obtained from the immediate postoperative CBCT to obtain the amount of bone height gain in mm for each implant (Figure 2).

3) Bone Density:

The bone density of the newly formed bone around the implant was measured in the cross-sectional cut buccal and palatal to the implant. The mean of these measurements on grayscale CBCT was recorded for each group.

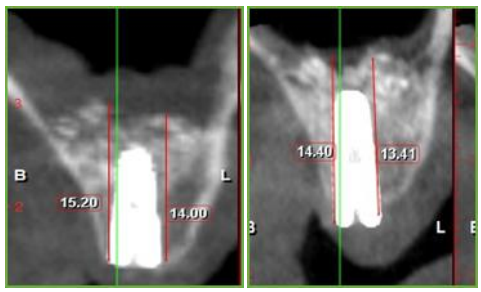

Figure 2. Bone height gain: (A) cross sectional immediate post-operative CBCT; (B) 6 months post-operative CBCT (The authors' elaboration)

2.9. Statistical Analysis

The data were collected, tabulated, fed to a computer, and statistically analyzed using IBM®SPSS Statistics version 23 for Windows. using range (minimum and maximum), mean, and standard deviation. Student's t-test was used to compare two studied groups, and the significance level was set at P value < 0.05.

3. Results

Twenty patients were evaluated, each group consisted of 10 patients. Concerning sinus membrane perforation was four perforations occurred in conventional surgery group (40%). However, only one membrane perforation occurred in the trephine group (10%) during the sinus lifting surgery. The perforations were closed with a resorbable collagen membrane and the grafting procedure was completed.

3.1. Vertical Bone Gain

The bone gain was 8.58±1.17 mm in conventional group (GI) and 9.99±1.57 mm in the trephine group (G II), and G II showed significantly ($p<0.05$) higher bone gain values than GI at postoperative time points, as revealed by independent t-test ($p<0.001$*).

3.2. Implant Stability Quotient (ISQ)

The Implant stability quotient (ISQ) in GI recorded a level of an average (±SD) of 70.88±2.07 and 77.80±3.11 in operative and 6 months post-operative; respectively. However, ISQ in GII recorded an average (±SD) level of 65.80±2.19 and 76.86±2.19, respectively, in the operative and 6-months post-operative; respectively. No statistically significant differences were found between the two treatment groups.

3.3. Bone Density

There was no statistically significant difference between the two groups after six months (p value>0.05).

3.4. The Duration of Surgical Procedures

The duration of surgical procedure (minutes) in GI ranged between 30-50 minutes with an average of 40.86±4.88 minutes. However, the duration of the surgical procedure (minutes) in GII ranged between 20 to 38 minutes with an average of 29.02±4.10 minute. The duration of surgical procedures was significantly ($p<0.001$*) longer (time in minutes) by 11.84 minute, it was generally observed that the procedure chair-side time was reduced with GII SLA.

Table 1. Research results (The authors' elaboration)

		G I	G II	P Value
Bone gain (mm)	Immediate Post-Operative Buccal	8.95±1.02	10.34±1.62	<0.001*
	Immediate Post-Operative Palatal	8.65±1.21	10.53±1.61	<0.001*
	6 Months Post-Operative Buccal	8.58±1.17	9.99±1.57	<0.001*
	6 months postoperative Palatal	8.45±1.52	10.02±1.82	<0.001*
ISQ reading	Initial	70.88±2.07	65.80±2.19	<0.001*
	6 months postoperative	77.80±3.11	76.86±2.19	<0.001*
Bone density	Immediate postoperative	506.04±50.89	505.86±50.39	<0.001*
	6 months postoperative	828.14±109.63	827.14±109.72	<0.001*
Duration of surgical procedure		40.86±4.88	29.02±4.1	<0.001*

Notes: * significant at $p<0.05$; ns - non-significant at $p > 0.05$

4. Discussion

Successful sinus elevation depends greatly on the patient's physical condition. The position of sinus floor convolutions, presence of septa, transient mucosal swelling, and a narrow sinus may be contraindications for sinus floor elevation. Absolute contraindications include maxillary sinus tumors and destructive previous sinus surgery, such as the Caldwell-Luc operation [8].

The lateral sinus wall is usually a thin bone plate that can be easily penetrated by rotating or sharp instruments. A fragile sinus membrane plays an important role in the containment of bone grafts applied to the sinus cavity. The process of preparing and elevating the window, together with the preparation of the sinus mucosa, may cause a mucosal tear. When these perforations are not too large, they usually fold together when the trap window is turned inward and upward, and can be glued with a fibrin sealant or covered with a resorbable collagen membrane. If the perforation is too large, the procedure is aborted [9-13].

The main aim of the present study was to evaluate the effectiveness of using a conventional DASK system versus a trephine bur SLA in the lateral window approach of sinus lifting with simultaneous implant placement.

In this randomized clinical study, the conventional DASK group was exposed to the lateral sinus wall. Osteotomy was performed with rotative DASK (Dentium Advanced Sinus Kit) drill #4 or #5 with drill speed 800 to 1200 rpm with internal irrigation in the conventional rotative DASK® group with copious sterile saline. Drill #4 and #5 with a diameter of 6.0

mm and 8.0 mm respectively and length of 2.5 mm has diamond coating cutting surface. Sinus membrane dissection and elevation were performed using direct sinus lift elevators.

To minimize the incidence of sinus membrane perforation, a new trephine design (SLA®® KIT-Neobiotech) was developed and used for lateral window creation. The kit is described in [14] and [15]. It contains two types of reamers (C reamer and LS reamer) that can be mounted on the implant handpiece. Both reamers have diameters of 4.5 mm, 5.5 mm and 6.5 mm. Heights of C reamers are 1.5 mm and 3 mm and the LS Reamer drills have heights of 2 mm and3.5 mm. This specially designed drill has the unique ability to cut bone on the lateral aspect of the drill without cutting in the mid-section, thus creating a window with slight membrane evaluation and without damaging the membrane.

In the present study, the ridge height in the conventional DASK group were average of 5.57±0.50 mm, and in the trephine bur SLA group were 5.16± 0.53 mm. An implant length of 10 mm was selected to provide space for endosinus bone formation [16]. This is in accordance with the findings of [17]. It was shown that it was possible to achieve implant stability even when the available bone height was limited to 4–5 mm. This is also in agreement with the results of [18]. In 2006, the minimal prerequisite for achieving primary stability of an implant was the presence of a layer of cortical bone that could be only 2 mm in length.

Various graft materials have been used for sinus augmentation. In this study, a deproteinized bovine bone mineral, BIO-GAP**,** was used. The Bio-gap is supplied in block form and may be in cancellous or cortical-derived particulate form. the use of xenogeneic bone graft and autogenous bone graft in surgically created defects in the lateral surface of mandible in dogs was compared in [19], they reported that the resorption rate of xenografts is slower than autogenous grafts.

The most commonly reported intraoperative complication of sinus augmentation is membrane perforation. It has been reported to occur in 7-35% of sinus floor elevation procedures. An intact sinus membrane is essential for graft stability and prevention of sinus infection [6].

In the present study, when conventional DASK instruments were used, overall perforation was in four patients (40%). In contrast, when the reamers were used, overall perforation was observed in only one patient (10%), which compared favorably to the perforation rate reported in multiple systematic reviews [20]. These findings are in agreement with the previously reported data [7]. They concluded that the SLA kit has the advantage of minimizing the sinus membrane perforation rate compared with conventional rotary instruments.

In the present study, the five perforations were managed by careful further elevation of the membrane until it folded on itself and placement of the collagen membrane just below the perforation.

In the current study, the bone gain was 8.58±1.17 mm in the conventional DASK group and 9.99±1.57 mm in the trephine bur SLA group, these values indicate there were no significant differences between the two groups in the extent of sinus floor elevation. These findings agree with those of [21] where the mean graft height was 14 mm, which is somewhat similar to that of [22] where the mean graft height was 9 mm. However, with the lateral sinus lift, the volume of new space created by the implant placement and the new bone formed appeared to be strongly correlated with the degree of membrane lift and the volume of bone grafting material used.

In the current study, the Implant stability quotient (ISQ)in the conventional DASK group recorded a level of an average(±SD) of 70.88±2.07 and 77.80±3.11 in operative and 6 months post-operative; respectively.

However, ISQ in the trephine bur SLA group recorded a level of an average (±SD) of 65.80±2.19 and 76.86±2.19 in operative and 6-months post-operative; respectively. No statistically significant differences were found between the two treatment groups.

In the present study, the mean radiographic bone density scores showed a highly significant difference across the studied samples, and the overall differences between the time points were highly significant. However, there were no statistically significant differences between the two groups. The present study is in agreement with similar results obtained previously [23].

In the present study, the duration of the surgical procedures in minutes was recorded and analyzed. The duration of the surgical procedure (minutes) in the conventional DASK group ranged between 30-50 minutes with an average of 40.86±4.88 minutes. However, in the trephine bur, the SLA group ranged between 20 and 38 min, with an average of 29.02±4.10 minute. The duration of surgical procedures was significantly ($p<0.001$*) longer by 11.84 minute, it was generally observed that the procedure chair side time was reduced with GII SLA®®. These findings are in agreement with those of [7] which concluded that the operative time was significantly shorter when using the trephine drill (11.1 ± 2.4 minutes) than when using conventional rotary instruments (15.1±2.9 minutes) ($P<.001$).

In this study, postoperative pain and swelling were not significantly different between the groups. Pain and swelling are the most common complications due to the nature of bone surgery, and intraoperative trauma to bone tissue is the most prominent causative factor. In

the current study, sufficient irrigation, more precise cutting, and less pressure during bone manipulation in both groups provided less postoperative pain and swelling.

5. Conclusion

1) The use of trephine drills of the SLA system mounted in a handpiece allows better access to the lateral approach owing to its perpendicular position relative to the sinus wall. The shape of the contact area of the drill minimizes the risk of sinus membrane perforation during the osteotomy.

2) The SLA trephine drills effectively reduce the incidence of sinus membrane perforation, and this technique proved to be less time consuming, less invasive, and reduced postoperative discomfort to the patient compared to the conventional DASK system.

3) Perforations of the sinus membrane were more frequent in direct sinus lift when using the conventional DASK system (40%) than with SLA trephine burs (10%), with no significant difference in the survival of the implants and bone gain in both comparative groups.

Recommendations

Further studies with larger sample sizes and longer follow-up periods are required to assess the definitive results of both interventions and to evaluate their performance and patient-related outcomes.

Declarations

Author Contributions

Conceptualization, A.M.I.S. and H.E.-D.M.A.; methodology, A.M.I.S. and H.E.-D.M.A.; software, H.E.-D.M.A.; validation, A.M.I.S., H.E.-D.M.A. and A.O.A.; formal analysis, A.M.I.S.; investigation, A.M.I.S., H.E.-D.M.A. and A.O.A.; resources, H.E.-D.M.A.; data curation, A.M.I.S.; writing—original draft preparation, A.O.A.; writing—review and editing, A.M.I.S.; visualization, A.O.A.; supervision, A.M.I.S.; project administration, A.M.I.S. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

The data presented in this study are available on request from the corresponding author.

Funding

Funding information is not available.

Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki. The research protocol was approved by the Ethics Committee of the Faculty of Dental Medicine, Al-Azhar University, Assuit Branch (N: AUAREC2023000105).

Informed Consent Statement

All details regarding the surgical procedure, postoperative follow-up, research procedures, and associated risks of the study procedures were explained to all patients.

All patients agreed to participate in the study and signed an informed consent form at Al-Azhar University.

Conflicts of Interest

The authors declare that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

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