The Efficacy of a Modified Omega Wire Extension for the Treatment of Severely Damaged Primary Anterior Teeth

Naser Asl Aminabadi * / Ramin Mostofi Zadeh Farahani **

Objectives: *The restoration of the severely damaged anterior teeth is considered a serious challenge in contemporary dental practice. The aim of the present study was the clinical and radiographic evaluation of a modified omega loop technique for the restoration of the severely damaged primary anterior teeth.* ***Study design:*** *A total of 144 anterior teeth in 60 healthy children (male: 32, female: 28) aged 3-4 years, severely damaged by dental caries, were included in the present study. The root canal therapy was performed for the selected teeth. After the construction of the modified omega loop, coronal 4 mm of intracanal ZOE was removed. A thin layer of polycarboxylate cement was placed over ZOE followed by the insertion of the modified omega loop and subsequent restoration of the crown with an internal compomer core and an external composite restoration. The patients were followed at the intervals of 6, 12, and 24 months postoperatively.* ***Results:*** *The partial loss of the restorative material after 6 months occurred in 5.9% of the teeth. The failure rates after 12 and 24 months were 10.8% and 18.5%, respectively. The primary canines exhibited minimum loss of the restorative material. Two teeth exhibited pathological mobility after two years. There were not any signs of root fracture or recurrent caries in any of the restored teeth.* ***Conclusion:*** *It may be concluded that the modified omega loop is an efficient technique for the restoration of the severely damaged anterior teeth. The ease of manipulation and short chair-side time are further advantages of the technique.*
Keywords: *primary anterior teeth, pulpectomy, omega loop, retention.*
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INTRODUCTION

The partial or complete loss of coronal tooth structure in the primary dentition may occur due to dental caries or physical trauma.[1] Early childhood caries (ECC) and severe ECC are the most common causes for the destruction of primary anterior teeth.[2-4] Early loss of the primary anterior teeth may bring about functional problems in mastication and phonetics, lead to the development of parafunctional habits such as tongue thrust, and impair the esthetic appearance.[5] Considering the importance of the maintenance of these teeth in a functional status in the oral cavity, various techniques for the restoration of the damaged primary anterior teeth have been evolved.[6-8] However, the restoration of the severely mutilated primary anterior teeth is still considered a serious challenge in contemporary pediatric dentistry.

Formerly, the treatment of the severely damaged primary anterior teeth was based on the removal of these teeth. However, the consequences were dramatic, namely loss of vertical dimension of occlusion, tongue thrusting and mouth breathing habits, which are all the known sources of future malocclusion.[9,10] Several materials and different techniques have been proposed for the restoration of the severely damaged primary anterior teeth.[11-19] However, some associated problems limit the use of these techniques. Children are among the least manageable group of the patients. Therefore, it is necessary to minimize the chair-side time. Moreover, the direct adhesive restorative procedures do not always give satisfactory results because of the short and narrow crowns of anterior teeth with small surface for bonding, and the aprismatic nature of enamel that is difficult to acid etch.

Mortada and King suggested the use of an omega-shaped intracanal retainer followed by resin restoration of the crown.[20] The prognosis for this technique was good; an 18-month survival rate of 79.9% for the restored anterior teeth was observed. The “omega wire extension” was an easy-to-master and reliable method for the restoration of the severely damaged anterior teeth. However, we hypothesized that

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some modifications of the original technique may enhance the clinical applicability of the technique and improve the long-term prognosis. Modifications in tooth preparation and intracanal omega wire retainer entails judgment in the application of the basic principles of retention and resistance which include parallelism, length, and surface area, and also of the secondary factors including grooves, boxes, and pinholes.[21] Internal bevel in the proposed modification eliminates sharp edges, which are stress concentration areas. It also increases surface area for the purpose of bonding. A direct relationship exists between surface area and the retentive-resistance potential of the retainer. Thus, by increasing circumferential involvement through the addition of axial walls, retention and resistance are increased.[21] Proximal grooves enhance the retention and resistance by providing a distinct path of insertion that resists buccolingual displacement. A definite path of insertion has been recommended to provide resistance to displacement in any direction.[22] The modification of omega wire offers line of contact instead of point contact which would eventually lead to a greater retention and resistance of restoration. Another benefit of using modified omega wire retainer is that the parallel terminal arms facilitate the insertion of the omega wire to a great extent.[21,22] The aim of this study was to evaluate the long-term prognosis of the modified design of "omega loop" for the treatment of the severely damaged primary anterior teeth.

MATERIALS AND METHOD

Study population

This study was performed at the Department of Pediatric Dentistry. A total of 60 children (female: 28, male: 32) aged 3-4 years, affected by early childhood caries or rampant caries,[23] and without any confounding past medical history were included in the present study. Early childhood caries (ECC) is defined as the presence of one or more decayed (noncavitated or cavitated), missing (due to caries), or filled tooth surfaces in any primary tooth in a child 71 months of age or younger. On the other hand, rampant caries has been defined by Massler as a suddenly appearing, widespread, rapidly burrowing type of caries, resulting in early involvement of the pulp and affecting those teeth usually regarded as immune to ordinary decay.[23] The subjects had severely carious primary anterior teeth in maxilla and mandible. Thus, both ECC and rampant caries were included in the present study. The procedure, possible discomforts or risks as well as possible benefits were explained completely to the parents or legal guardians, and an informed consent form was obtained and recorded. This study was approved by the ethical as well as research committees.

After thorough clinical examination, the primary pariapical radiographs were taken. The selected subjects satisfied the following inclusion criteria:

- Healthy children without any confounding medical history
- Primary anterior teeth which were unrestorable using conventional techniques
- No fistula or sinus tract
- Lack of suppuration from root canals
- Normal complete root formation
- No pathological root resorption, root canal obliteration, and pariapical radiolucency
- Deleterious oral habits such as bruxism and digit sucking behavior[24]

Professional fluoride therapy was performed for patients 4 times during a period of 6 weeks. While fluoride therapy was necessary to increase the caries resistance, behavior shaping was an additional benefit derived from the procedure.

Treatment protocol

A four-stage treatment protocol according to Mortada and King was adopted:[20]

- Removal of dental caries
- Root canal therapy
- Placement of modified omega loop
- Resin restoration of crown

Construction of modified omega loop

A 0.5 mm round orthodontic stainless steel wire was used for making modified omega loop. Using orthodontic No. 130 pliers, a 2-mm length of wire was bent and shaped as an omega loop terminating to two parallel pulpal ends. The shape and size of the constructed loop complied with the tooth size and external root/crown contour being slightly larger in primary canines.

The loop consisted of an omega wire similar to the original version. This omega-shaped segment projected 2-3 mm above the coronal tooth segment. The omega loop provided extra retention for the restorative material. The intracanal segment consisted of two parallel L-shaped terminals of 3 mm length, which were introduced into the slots prepared at the mesial and distal aspects of the root canals (Fig. 1,2). The insertion of these parallel terminals into the conical root canals resulted in an inward bending and thus the activation of these arms. The terminal short projections of the L-shaped arm acted as an accessory retainer inside the restorative material.

Clinical procedures

After local anesthesia infiltration (Xylocaine® 2%, Epinephrine 1/100000, Dentsply, York, UK), removal of carious lesion was performed and root canal treatment was initiated. The RCT technique used herein was described by Payne *et al*.[25] Isolation of the operative field was accomplished through placement of a rubber dam. Access to the pulp cavity was achieved using a sterile No. 56 fissure bur mounted in a high-speed handpiece and then refined with round burs in low-speed handpiece. During access cavity preparation all remaining dental caries was removed. However the under-

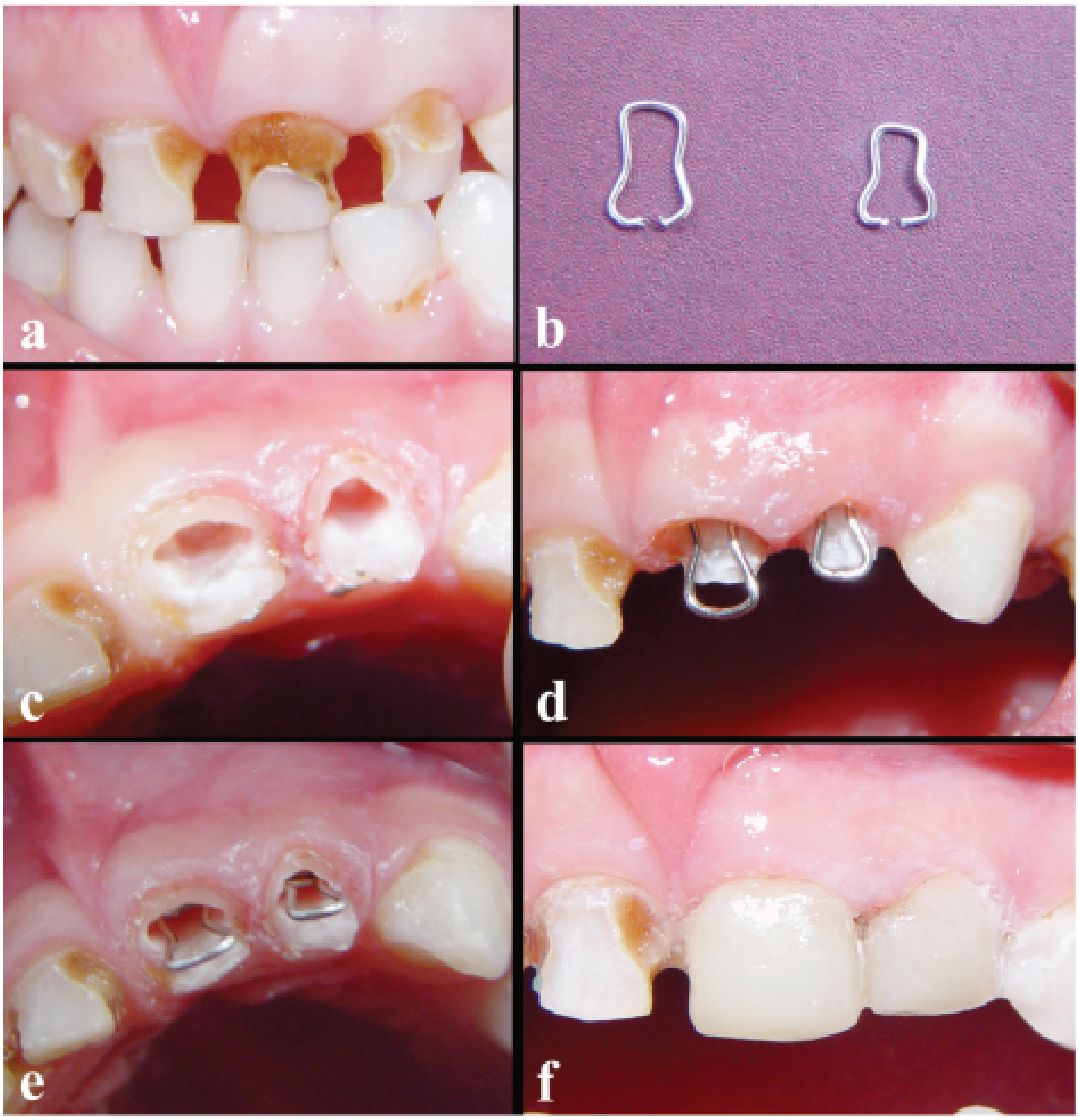

Figure 1. Modified omega wire technique. Preoperative view of the primary anterior incisors (a). Modified omega wire (b). Post-operative view of teeth after caries removal and root canal therapy (c). Intra-canal placement of omega wire (d). Note the slots at mesial and distal aspects of teeth (e). Post-operative view of restored teeth (f).

mined enamel pieces were left intact to preserve maximum sound tooth structure. The entire roof of pulp chamber and overhanging dentinal remnants were removed. An estimated working length, 2 mm short of the primary diagnostic radiographic length, was adopted. An initial endodontic K-file (MANI®, Tochigi, Japan) was introduced to the estimated working length. Through filing motion, in most cases pulp tissue was removed in first attempt. If the first attempt was unsuccessful, the procedure was repeated till extirpation of the entire pulp tissue. During the filing procedure, the enlargement of root canals may occur although it is a consequence rather than the primary aim. Copious irrigation was carried out with sterile 0.9% NaCl solution. Thereafter, canal was dried with paper points. Using a pressure syringe and starting at 2 mm from apex, canals were filled with ZOE (Caulk, Milford, USA).

After completion of the RCT, a 4-mm length of the coronal portion of the root canal filling was removed (1 mm longer than the cutting surface of the fissure bur). A thin layer of fast-setting polycarboxylate cement was applied to

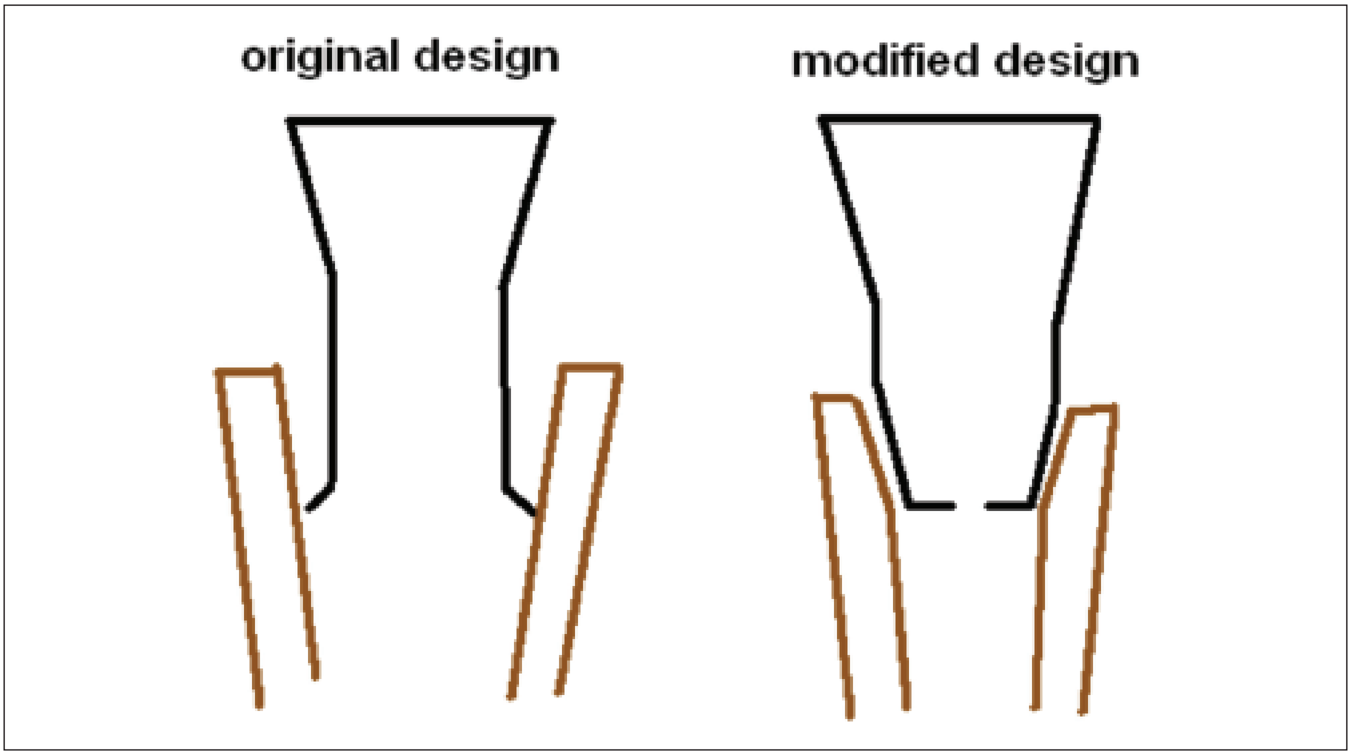

Figure 2. Schematic representation of original versus modified omega loop.

over the zinc oxide-eugenol as a physical barrier separating ZOE and resin restoration to prevent any interference with setting procedure of compomer restoration.

After complete setting of the cement, the excess polycarboxylate cement was removed and coronal 3-mm of the root canal was thoroughly cleaned for the insertion of the modified omega loop and resin restoration. Two parallel slots of 3-mm length were prepared in mesial and distal sides of the root canal. Moreover, an internal bevel at an angle of approximately 45 degrees was prepared circumferentially. The enamel and dentine surfaces were washed and gently dried. Then, conditioning of the pulp chamber and remaining coronal segment was performed for 30 s.

Subsequently, a compomer (Dyract, DeTrey, Dentsply, York, UK) was introduced into the root canal cavity. The modified omega loop was compressed using a needle holder and inserted into the prepared intracanal slot. Compomer was then light cured for 35 s.

Subsequent 2 mm layered light curing additions of compomer over the extra-canal omega loop continued up to the coronal core and 2 mm short of the anatomical crown. Thereafter, composite resin was used for restoration of the remaining crown anatomy. Then shape refining was accomplished and occlusal interferences were removed. Final finishing and polishing of the restorations were performed with diamond finishing burs and disks and interdental strips.

Postoperative evaluation

A secondary radiograph was taken to locate the modified omega loop inside the canal and to rule out any probable risk of dislodgment of loop during operation. Patients were recalled at 6, 12, and 24 months post-operatively. Clinical and radiographic reassessment of the restorations was performed. Retention of the restorations, existence of any fractures, recurrent caries, and periapical pathoses were examined.

RESULTS

A total of 144 primary anterior teeth were included in this study. The distribution patterns of these teeth in maxilla and mandible are presented in Table 1.

Table 1. Distribution of selected teeth in maxillary and mandibular arches.

Type trait	Maxilla	Mandible	Total
A	40	24	64
B	28	20	48
C	20	12	32
Total	88	56	144

The 144 restored teeth were recalled at 6, 12, and 24 months post-operatively. Drop-outs occurred through the first and second follow-ups owing to the reasons summarized in Table 2. However, the number of teeth was constant

Table 2. Number of drop-out cases and the underlying causes.

Drop-out causes	first recall	second recall
No access to subjects	8	4
Extraction following traumatic injuries	2	0

between second and third recall visits. Only two incisors in a male subject which were lost due to bicycle accident were notable and worthy of consideration.

Post-operative follow-ups revealed no signs of recurrent caries. Moreover, root fracture was not observed during recall visits. Two teeth were mobile and radiographic examination revealed periapical pathosis after two years. The number and percentage of the teeth exhibiting complete or partial retention of restorative material are presented in Table 3.

Table 3. The status of restored teeth during each follow-up period.

Recall periods (month)	Arch trait	type/class trait	evaluated restorations	complete retention	partial retention
6	Maxilla	A	34	30 (88%)	4 (12%)
		B	24	22 (91.6%)	(8.4%)
		C	20	20 (100%)	-
	Mandible	A	24	23 (95.8%)	1 (4.2%)
		B	20	19 (95%)	1 (5%)
		C	12	12 (100%)	-
12	Maxilla	A	32	28 (87.5%)	4 (12.5%)
		B	22	18 (81.8%)	4 (18.2%)
		C	20	19 (95%)	1 (5%)
	Mandible	A	24	21 (87.5%)	3 (12.5%)
		B	20	19 (95%)	(5%)
		C	12	12 (100%)	0
24	Maxilla	A	32	27 (84.4%)	5 (15.6%)
		B	22	15 (68.2%)	7 (31.8%)
		C	20	17 (85%)	3 (15%)
	Mandible	A	24	20 (83.3%)	4 (16.7%)
		B	20	17 (85%)	3 (15%)
		C	12	10 (83.3%)	2 (16.7%)

During first follow-up at sixth month post-operatively, complete retention was observed in 92.3% of maxillary and 96% of mandibular teeth. Primary canines all exhibited complete retention both in maxilla and mandible. During second post-operative evaluation the complete retention rate in maxillary and mandibular anterior teeth was 87.8% and 92.8%, respectively. Again during this period, primary canines exhibited maximum retention rate. After two years, 79.7% of maxillary teeth and 83.9% of mandibular teeth retained the restorative material completely.

The partial loss of restorative material from those teeth restored using modified omega loop was 5.9% after 6 months. However, the number of teeth exhibiting partial loss of restorative material nearly doubled after 12 months and reached 10.8%. After two years, 18.5% of restored teeth lost a part of restorative materials. In addition, two teeth with periapical pathosis (1.5%) enhanced the failure rate of the modified omega loop technique to 12.3%.

DISCUSSION

The aim of the present study was to evaluate the long term prognosis of a modified version of omega loop. The Clinical and radiographic examinations proved the technique to be efficient.

Severely damaged anterior teeth pose a serious challenge for the astute clinician owing to the lack of a sufficient coronal structure, which may be used for an effective esthetic restoration. Moreover, poor bonding of the adhesive agent to enamel and dentin in the primary dentition could compromise the prognosis of these restorations.[26,27] It has been demonstrated that the carious process has a deleterious effect on the mechanical properties of dentin in primary incisors increasing the likelihood of restorative failure.[28] For this reason, the application of supplementary retention devices enhancing the survival rate of restoration are necessary. Unfortunately, several biological problems might limit the use of conventional retention devices. The most important limitation is physiological root resorption, if the intracanal post is inserted deep into the canal. Root canal anatomy of primary teeth is also prone to fracture from internal stress concentration.

The introduction of omega wire extension solved most of the problems. It was not inserted deep into the canals. Also layered build-up material minimized the likelihood of development of internal stress concentration areas. Therefore, the risks of interference with physiological root resorption and root fracture were actually countervailed.

The modified omega loop design is an attempt to diminish some inherent problems associated with its original design. Insertion of the omega wire is facilitated to a great extent from the parallel slots and the parallel terminal of the omega wire. In addition, after placement into the canal, the wire exhibits higher stability and reduce risk of dislodgement subsequent to application and manipulation of restorative material.

The internal bevel eliminates sharp edges, which are actually stress concentration points. Other accessory benefits derived from internal bevel include increased surface area which can be used for the purpose of bonding and also the enhanced ease of insertion of the wire into the root canal. Gilboe and Teteruck concluded that a direct relationship exists between surface area and the retentive-resistance potential of the retainer. By increasing circumferential involvement through the addition of axial walls, retention and resistance are increased.[21]

While the partial loss of restorative material in the original omega wire technique after six months was 19.5%,[20] the use of modified version reduced the failure rate to 5.9% in our study. After 12 months, the failure rate of original design was 24.4%.[20] The use of modified design revealed a failure rate of 10.8% which is well below that of the original design.

According to Judd *et al*,[29] mandibular lateral incisor and canine are most prone to failure if there are occlusal interferences during mandibular parafunctional movements, or physiological forward mandibular shift. Our findings indicated that mandibular canine exhibited minimum long-term failure. Meticulous dynamic and static occlusal adjustments offset the aforementioned risk and the survival rate of these teeth may even surpass those of other treated teeth.

The cosmetic results of the present study were acceptable. Moreover, the chair-side time with this technique decreased to a great extent. In addition, the technique eliminates laboratory processing and is economical both in time and expense.

CONCLUSION

It may be concluded that the modified omega loop technique is an appropriate treatment modality for the severely damaged primary anterior teeth. The technique provides the clinician with the ease of use, excellent cosmetic outcome, and good prognosis. Substitution of the modified version for the original one is suggested.

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