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Modified Ridge Splitting and Bone Expansion Osteotomy with Guided Bone Regeneration by Demineralized Freeze-dried Bone Allograft and Platelet-rich Fibrin Membrane for Placement of Dental Implant in Esthetic Zone

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ABSTRACT

Insufficient width of the alveolar ridge often prevents ideal implant placement. Alveolar ridge splitting, modified ridge splitting, bone expansion osteotomy, bone grafting, guided bone regeneration and combinations of these techniques are used for the lateral augmentation of the alveolar ridge.

AIMS AND OBJECTIVES: This study was carried out to compare the mean labio-palatal width (LPW) of alveolar ridge pre-splitting and post-splitting with implant placement, mean LPW of alveolar ridge between pre-prosthesis and post-prosthesis after six months; and to find out mean LPW of alveolar ridge before treatment and post-treatment of implant placement.

MATERIALS AND METHODS: 10 patients were treated for single tooth replacement in esthetic zone by placement of implants by modified ridge splitting and bone expansion osteotomy with guided bone regeneration. Bone regeneration was achieved by demineralized freeze-dried bone allograft (DFDBA) and platelet-rich fibrin (PRF) membrane. In this study, we carried out modified ridge split and bone expansion osteotomy with simultaneous implant placement in esthetic zone. The osseous defect was filled with DFDBA and covered by PRF membrane after the implant of suitable dimension was placed. The patients were followed to see the response of rehabilitation clinically & radiographically for six months after loading of implant.

RESULTS: Mean value for pre-split LPW was 3.70 ± 0.42 mm while post-split mean LPW was 6.65 ± 0.47 mm. Thus, mean gain in crestal ridge after post-split was 2.95 mm. Pre-prosthesis mean LPW was 6.15 ± 0.47 mm while post-prosthesis LPW was 5.95 ± 0.36 mm. Thus, there was mean loss of 0.20 mm which may be due to functional adaptation of alveolar bone after implant loading. Pre-treatment LPW was 3.70 ± 0.42 mm and post-treatment LPW become 5.95 ± 0.36 mm. Thus, there was mean gain of 2.25 mm of LPW of alveolar bone compared to pre-treatment LPW of alveolar bone.

CONCLUSION: Modified ridge splitting and bone expansion osteotomy with guided bone regeneration by DFDBA and PRF membrane for placement of dental implant in esthetic zone showed the predictable results.

Keywords: Alveolar ridge augmentation, dental implants, narrow alveolar ridge, osteotomy, ridge expansion, ridge splitting.

INTRODUCTION

Insufficient width of the alveolar ridge often prevents ideal implant placement. Guided bone regeneration, bone grafting, alveolar ridge splitting and combinations of these techniques are used for the lateral augmentation of the alveolar ridge. Ridge splitting is a minimally invasive technique indicated for alveolar ridges with adequate height, which enables immediate implant placement and eliminates morbidity and overall treatment time. The classical approach of the technique involves splitting the alveolar ridge into two parts with use of osteotomes and chisels. Modifications of this technique include

the use of rotating instrument, screw spreaders, horizontal spreaders and ultrasonic device [1].

The aims and objectives of this study was to measure and compare the mean labio-palatal width of alveolar ridge pre-splitting and post-splitting with implant placement, to compare between pre-prosthesis and post-prosthesis after six months mean labio-palatal width of alveolar ridge; and to find out mean labio-palatal width of alveolar ridge before treatment and post-treatment of implant placement.

MATERIALS AND METHODS:

10 patients were recruited from the outpatient department of Periodontology and Implantology, Chandra Dental College & Hospital, Barabanki, Uttar Pradesh, India, with chief complaint of missing upper front tooth since one year and who requested a fixed prosthesis, preferably an implant-supported one; according to inclusion and exclusion criteria. Patients' **i**nclusion criteria were non-contributory medical/social and family history, partial upper front edentulous alveolar ridge; insufficient labio-palatal width of alveolar ridge for implant placement, alveolar ridge width was at least 3 mm and indicated for a ridge split and lateral expansion. Exclusion criteria were insufficient alveolar ridge height for implant placement without violation of implant: crown ratio, immuno-compromised patients, chronic smokers, infections/ pathological conditions at the planned surgical site, medically compromised patients, poor oral hygiene. Pre-operative and post-operative parameters were taken by initial and final alveolar ridge width assessment using CBCT. Investigations done were routine blood investigations (BT, CT, Hb % & RBS), Denta Scan/ appropriate CT modality, IOPA radiograph, and OPG. Follow-up was done six months post operatively after implant placement, and six months after fabrication of prosthesis.

Pre-operative evaluations of implant site were done by clinical examination of soft tissue and radiographic evaluation of hard tissue. Gingiva was examined for texture, consistency and thickness. Trans-gingival probing was done to evaluate bone topography. Occlusion and inter-occlusal/incisal space were also assessed. Preoperative computed tomography (CT); IOPA radiograph and OPG were taken to assess the quality & quantity of bone at the implant placement site and used as a guide in determining the size of implant to be used [Figure 1-3].

Before treatment, verbal and written consents were obtained from the patient. This study was approved by the institutional ethical committee for human subjects and also conducted in accordance with the declaration of Helsinki in 1975, as revised in 2000.

The patients were instructed to do pre-surgical rinse by 0.2% chlorhexidine solution. The facial skin around the mouth was cleaned with spirit and scrubbed by 7.5% povidone-iodine solution. The intraoral surgical site was painted with 5% povidone-iodine solution [2].

Pre-operative antibiotics and analgesic were prescribed and the patient was prepared in a sterile environment. Local anesthesia, lignocaine 2% containing 1:80,000 adrenaline was injected in the area of surgery as an infiltration. A crestal incision was given and combined muco-periosteal and mucosal flap was reflected on labial aspect and only muco-periosteal flap on palatal side. The combined flap provides advantage of proper flap closure after ridge expansion. The exact location of implant on the ridge was marked by an indentation created by surgical blade. Four types of ridge expanding instruments namely, oscillating saw, uni-beveled chisel, bi-beveled osteotome and tapered osteotomes were used in the surgery. Chisels and osteotomes were used by gentle tapping with mallet. Using uni-beveled chisel (2 mm), with bevel facing labial side, an indentation made on crestal cortex was perforated to reach cancellous bone. Oscillating saw was used to make cuts mesial and distal to osteotomy on the buccal cortex. The bi-beveled osteotome 2.5 mm, 3.5 mm in length and tapered osteotome 2 mm, 3 mm diameter at the tip were used alternately to expand the osteotomy. All the instruments after tapping to desired depth were wiggled back and forth in a mesio-distal direction with slight buccal pressure. This allows expansion of ridge facially with advancing osteotomy as well as easy removal of instrument without any risk of fracturing the labial plate. Any crestal resistance if felt before reaching desired depth was relieved by further advancing oscillating saw cuts mesial and distal to osteotomy. It was done using uni-beveled chisel. This oscillating saw cut extension allowed better relieving of stress concentrated at the crest during ridge expansion with

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osteotomes. Similarly, any apical resistance if felt was relieved by the smallest diameter pilot drill by untouching the crestal bone. The final instruments closely matched the shape of the implant. Self-tapping, threaded, implant of suitable length and diameter was carefully placed in expanded osteotomy at same surgical appointment. In all the cases, osseous defect was filled up with DFDBA and covered with a PRF membrane after the implant of suitable dimension was placed and sutured [Figure 4-11]. After six months of implant placement, radiographic evaluation of bone around implant was done [Figure 12]. Prosthesis was fabricated after clinical and radiographical evaluation of the implant site. After six months of fabrication of prosthesis, that is, one year from placement of implant, labio-palatal width of alveolar bone was measured [Figure 13-14]. The final esthetic after 1 year shows esthetically satisfactory result [Figure 15].

RESULTS:

Mean value for pre-split labio-palatal width was 3.70 ± 0.42 mm while post-split mean labio-palatal width was 6.65 ± 0.47 mm [Table 1- 2, Graph 1]. Thus, mean gain in crestal ridge after post-split was 2.95 mm. Pre-prosthesis mean labio-palatal width was 6.15 ± 0.47 mm while post-prosthesis labio-palatal width was 5.95 ± 0.36 mm [Table 3- 4, Graph 2]. Thus, there was mean loss of 0.20 mm which may be due to functional adaptation of alveolar bone after implant loading. Pre-treatment labio-palatal width was 3.70 ± 0.42 mm and post-treatment labio-palatal width becomes 5.95 ± 0.36 mm Table 5- 6, Graph 3]. Thus, after six months of functional loading of implant, there was mean gain of 2.25 mm of labio-palatal width of alveolar bone compared to pre-split labio-palatal width of alveolar bone

DISCUSSION:

It is well-established that alveolar ridge <5 mm requires augmentation procedure in order to receive endosseous implant with healthy peri-implant bone of 1.5 to 2 mm. If implants are placed in areas of inadequate ridge width then following problems can occur: Dehiscence of labial bone predisposing chances of peri-implantitis, leading to unesthetic metal display through gingiva, leaving a thin bone <1-1.5 mm may predispose to resorption of thinner labial plate in near future, meeting gingival recession and implant exposure; and undercuts present on alveolar bone gives rise to off-axis loading. All these problems can be overcome by augmenting bone either through grafting or by other means. Various treatment options to manage horizontally deficient ridge include increasing width by osteoplasty, using narrow diameter implant, ridge augmentation by autogenous block graft, corticocancellous particulate bone graft and allograft using GBR membrane, distraction osteogenesis and ridge splitting with bone expansion techniques [3].

Increasing width with osteoplasty results in FP2 and FP3 prosthesis. Narrow diameter implant presents greater mesial and distal cantilever, thus higher tendency of fatigue fracture with abutment and its screw loosening [4]. Ridge augmentation with bone block and GBR technique carries additional donor site, long term waiting period 6-12 months, risk of membrane exposure, infection and increase cost to patient without 100% success rate [5, 6]. Distraction osteogenesis leaves patient uncomfortable and is cumbersome [7].

Although ridge splitting and bone expansion appears to be technique sensitive but has many advantages over different techniques [8, 9]. It takes advantage of inherent quality of flexibility of cancellous bone. Maxillary bone is pliable and can be slowly manipulated to improve quality (compaction and corticalization) and expanded to desired width. When clinicians allow times for manipulation of bone, it can eventually mold to desired location. It never allows loss of patient bone which is usually unavoidable by mere drilling procedure [10]. The success of this technique also depends on maintaining integrity of labial bone, which occurs as long as periosteum is intact. Periosteum due to its elastic nature allows bone expansion and manipulation and acts as a barrier membrane and makes micro-fracture heal very well because of intact blood supply. Hence it is advisable to leave intact periosteum encasing the bone which can achieved by raising conservative muco-periosteal flap in area of implant placement and then further mucosal flap to coronally advance flap closure.

The ideal indications of ridge splitting and bone expansion procedure are those sites that do not require vertical ridge augmentation and having cancellous bone present between labial and palatal cortical plates. It can be best done in a narrow ridge

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of minimum 3 mm with greater preference in maxillary bone over mandibular bone.

The technique of ridge expansion osteotomy developed by Summers uses sequence of progressively increasing osteotome to create an osteotomy closely receptacle to implant dimension [8, 9]. Though this technique provides atraumatic approach for bucco-lingually deficient ridge but Padmanabhan and Gupta demonstrated greater crestal bone loss associated with osteotome technique compared to conventional technique [11]. However, they made no attempt to relieve stresses at crest associated with the use of oseotome. The extension of chisel cut mesial and distal to osteotomy prevents stress concentration at the crest and thus crestal bone loss.

Several authors advocated different ridge split technique in which crestal cut osteotomy is joined to adjacent vertical osteotomy cut on either or on both sides followed by creation of greenstick fracture of buccal plate [12,13]. After the expansion of osteotomy to appropriate size, it is either grafted with bone graft (two steps) [14] or implant is placed at same appointment (single step) [15]. This technique jeopardizes the blood supply to the fractured buccal plate and hence rate of sequestration is high if not done carefully [16].

In this study, mean value for pre-split LPW was 3.70 ± 0.42 mm while post-split mean LPW was 6.65 ± 0.47 mm. Thus, mean gain in crestal ridge after post-split was 2.95 mm. Pre-treatment LPW was 3.70 ± 0.42 mm and post-treatment LPW become 5.95 ± 0.36 mm. Thus, there was mean gain of 2.25 mm of LPW of alveolar bone compared to pre-treatment LPW of alveolar bone. Rahpeyma *et al.* found mean value for pre-split width of 3.2 ± 0.34 mm and post-split mean width of 5.5 ± 0.49 mm by lateral ridge split and immediate implant placement in moderately resorbed alveolar ridges. The mean gain in crest ridge after ride splitting was 2 ± 0.3 mm [17]. Anitua *et al.* clinically evaluated the split-crest technique with ultrasonography bone surgery for narrow ridge expansion. They showed a mean ridge expansion of 3.35 ± 0.34 mm when measured and compared bone ridge at final examination [18].

CONCLUSION:

Modified ridge splitting and bone expansion osteotomy with guided bone regeneration by DFDBA and PRF membrane for placement of dental implant in esthetic zone showed the predictable results when proper case selection and careful surgery was performed. This technique if done skillfully and carefully can be helpful to expand and remove labial undercuts, which are major causes of fenestration during implant placement. This will also prevent off-axis loading.

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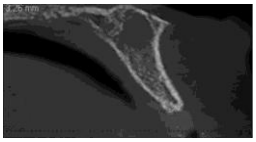
FIGURES

Figure 1: Pre-operative clinical view	**Figure 2: Pre-operative radiographic view**	**Figure 3: Pre-operative cross sectional image showing 4.0 mm width at crest**
		
Figure 4: Pre-operative width at the crest	**Figure 5: Use of oscillating saw to cut the cortex and crestal bone**	**Figure 6: Use of Bi-beveled osteotome to initiate splitting and expansion laterally.**
		
Figure7: Tapered ostetome used to progress osteotomy	**Figure 8: Crest after ridge splitting**	**Figure 9: Implant placement**
		
Figure 10: PRF and bone graft placed	**Figure 11: Suturing done**	**Figure 12: Post-operative radiographic view after six months of implant placement**
		
Figure 13: Post-operative IOPA X-ray after one year	**Figure 14: Post-operative cross sectional image after one year**	**Figure 15:Post-opratve clinical view after one year**
		

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TABLES

Table 1: Mean pre-split and post-split labio-palatal width of alveolar ridge

Pre-split labio-palatal width		Post-split labio-palatal width	
Mean	3.7	Mean	6.65
Standard Deviation	0.421637021	Standard Deviation	0.474342
Sample Variance	0.177777778	Sample Variance	0.225
Range	1.5	Range	1.5
Minimum	3	Minimum	6
Maximum	4.5	Maximum	7.5

Table 2: Comparison between changes in mean pre-split and post-split labio-palatal width of alveolar ridge

t-Test: Paired Two Sample for Means		
	Pre- split labio-palatal width	Post- split labio-palatal width
Mean	3.7	6.65
Variance	0.177777778	0.225
t stat	-59	

Table 3: Mean pre-prosthesis and post-prosthesis labio-palatal width of alveolar ridge

Pre -prosthesis labio-palatal width		Post- prosthesis labio-palatal width	
Mean	6.15	Mean	5.95
Standard deviation	0.474341649	Standard deviation	0.368932
Sample variance	0.225	Sample variance	0.136111
Range	1.5	Range	1
Minimum	5.5	Minimum	5.5
Maximum	7	Maximum	6.5

Table 4: Comparison between changes in mean pre-prosthesis and post-prosthesis labio-palatal width of alveolar ridge

t-Test: Paired two sample for means		
	Pre -prosthesis labio-palatal width	Post- prosthesis labio-palatal width
Mean	6.15	5.95
Variance	0.225	0.136111111
t stat	2.449489743	

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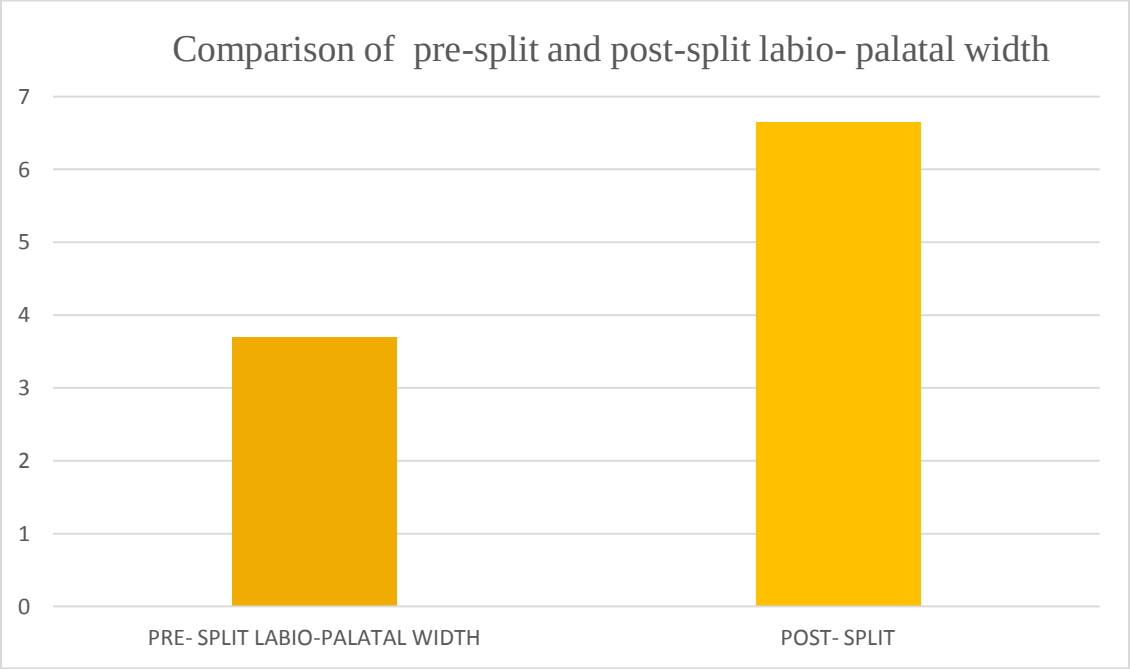
Table 5: Mean pre-split and post-prosthesis labio-palatal width of alveolar ridge

Pre-split labio-palatal width		Post-prosthesis labio-palatal width	
Mean	3.7	Mean	5.95
Standard Deviation	0.421637021	Standard Deviation	0.368932
Sample Variance	0.177777778	Sample Variance	0.136111
Range	1.5	Range	1
Minimum	3	Minimum	5.5
Maximum	4.5	Maximum	6.5

Table 6: Comparison between pre-split and post-prosthesis labio-palatal width of alveolar ridge

t-Test: Paired two sample for means		
	Pre- split labio-palatal width	Post- prosthesis labio-palatal width
Mean	3.7	5.95
Variance	0.177777778	0.136111111
t Stat	-59	

GRAPHS



Graph 1: Showing pre-split and post-split labio-palatal width of alveolar ridge

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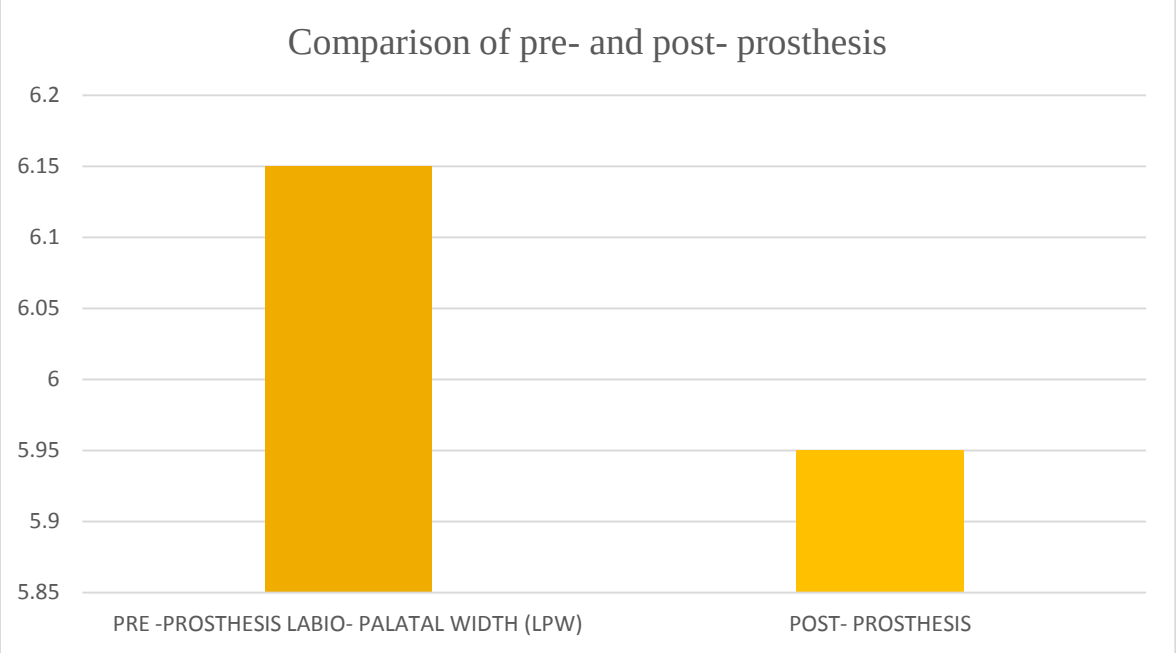
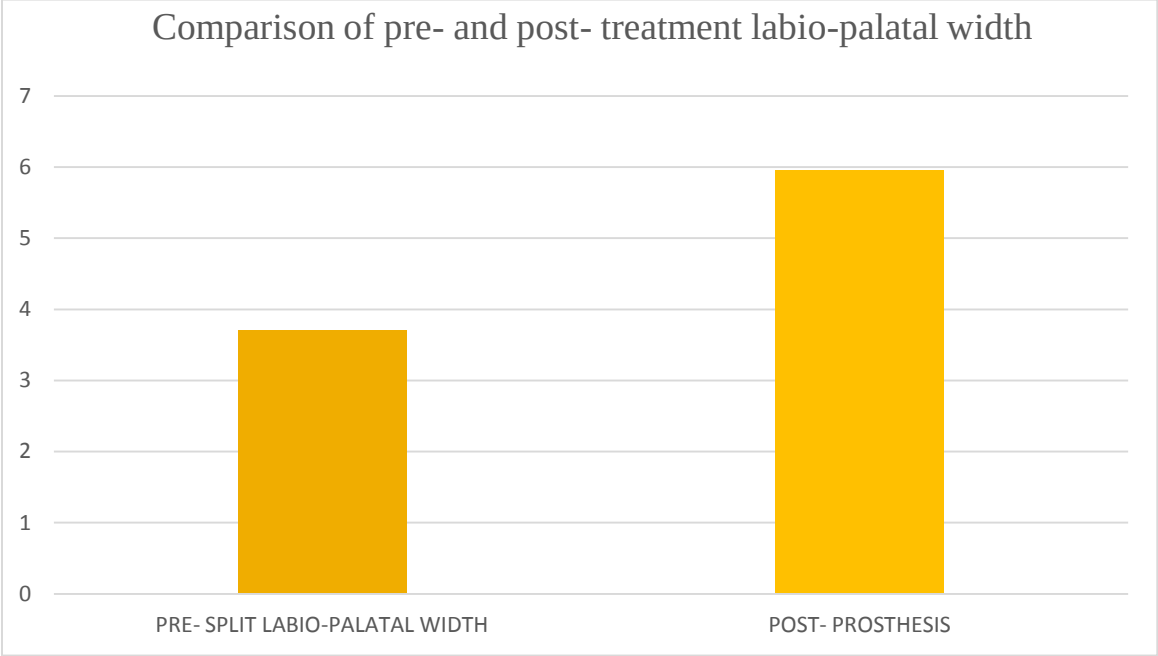


Graph 2: Showing pre-prosthesis and post-prosthesis labio-palatal width of alveolar ridge



Graph 3: Showing pre-treatment and post-treatment labio-palatal width of alveolar ridge

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