Original Article

Characteristics of Gingival Biotype of Maxillary Incisors in Thai Young Adults

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Abstract

The aim of this study was to determine gingival phenotype prevalence and characteristics in maxillary incisors in young adults. The maxillary incisors of 100 periodontally healthy subjects (mean age 22.20±0.84 years) were examined by 2 calibrated examiners. The gingival phenotype was identified using transparency probing and visual inspection. Clinical parameters; probing depth, gingival recession, clinical attachment level, gingival width, papilla height, and tooth shape were determined. Descriptive analysis was performed and the clinical parameters between gingival phenotypes were compared using the *t*-test and ANOVA. The result demonstrated that maxillary incisor teeth displayed a thin phenotype (66 %) when assessed using probe translucency. The gingival phenotype was associated with tooth shape ($p<0.01$). Thin gingival phenotype showed significantly narrower gingival width, but higher papilla height compared with the thick phenotype ($p<0.001$). A scalloped gingival contour was noted when the papilla height was more than or equal to 4 mm. A thick-flat, thick-scalloped, and thin-scalloped contour was associated with square, ovoid, and triangular tooth shape, respectively. In conclusion, most subjects demonstrated a thin gingival phenotype. The thin phenotype was associated with higher papilla height and triangular tooth shape, while the thick phenotype was associated with broader keratinized tissue width and ovoid/square tooth shape.

Keyword: Gingival phenotype, Gingival biotype, Papilla height, Tooth shape, Maxillary incisors

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Introduction

Variations in the shape of teeth and periodontium between individuals have been observed for many years.[1] In 1969, Ochsenbein and Ross identified two types of gingiva architecture; scalloped-thin and flat-thick, depending on the underlying bone morphology and tooth shape.[2] Subsequently, several terms were proposed to describe the morphologic characteristics of gingiva. Soft tissue characteristics were defined as gingival phenotype or gingival biotype.[3,4] The term periodontal biotype[5] and periodontal morphotype[6] were also used to determine gingival morphology related to tooth shape, crown height, and gingival and bone morphology. Subsequently, gingival thickness, keratinized tissue, and tooth dimension were used to determine periodontal phenotype.[3]

The gingival phenotype has a significant impact on treatment outcome. The thin phenotype has higher risk of gingival recession and complete interdental papilla fill after an immediate implant placement.[7] Higher amount of marginal bone loss was observed in thin gingival phenotype. Other trauma or inflammation results in gingival recession in thin phenotype, while pocket formation is seen in thick phenotype.[1,8] Thick gingival phenotype demonstrated thick underlying bone.[9] Thus, minimal ridge resorption is occurred after surgery, leading to more predictable result.[10] The gingival phenotype was found to be the most significant factor to determine the facial gingival margin in dental implants.[11]

The gingival phenotype can be determined using several methods. Direct measurement is the most accurate method to determine gingival thickness[8,12] however, the injection to anaesthetize the tissue can traumatize the gingiva and create discomfort. Alternative methods were proposed, using a periodontal probe seen through the gingiva[13] or visual assessment.[14] Some technologies such as ultrasound and Cone Beam Computed Tomography (CBCT) can be also be used to determine gingival thickness with minimal tissue trauma and better accuracy.[9,15,16] However, transparency probing and visual assessment are still more practical and widely used due to their simplicity.

Gingival contour is the appearance of gingival morphology in relation to teeth. It can be either flat or scalloped contour. Along with the visual assessment, the gingival contour can be classified into 3 categories; thin-scalloped, thick-flat and thick-scalloped contour.[14,17]

It has been shown that different population represented different gingival phenotype and contour.[18] To our knowledge, the gingival phenotype of maxillary incisors in relation to other clinical parameters is still inconclusive. Thus, the aim of the present study was determine the characteristics of gingival phenotype in to the maxillary incisors of a young adult periodontally healthy population.

Materials and Methods

Subjects

The study protocol was approved by the Ethics Committee, Faculty of Dentistry, Chulalongkorn University (Study ID: 3200502#45/2013) and has been conducted in full accordance with the World Medical Association Declaration of Helsinki. A hundred and five dental students from the Faculty of Dentistry, Chulalongkorn University, ages 20–24 participated in this cross-sectional study. Sample size calculation was performed. The inclusion criteria were; having all four maxillary anterior teeth, no history of orthodontic treatment, and good oral hygiene and gingival health. Subjects were excluded if there were clinical signs of periodontal disease defined as having pockets exceeding 3 mm or taking medications with any known effect on the periodontal soft tissues. Oral hygiene instructions, tooth polishing, and calculus removal (if necessary) were provided to all subjects. All subjects provided informed consent.

Clinical parameters

The intra- and inter-examiner reliability of the clinicians who performed the clinical examinations was determined. The Pearson's correlation coefficient of inter- and intra-examiner reliability was 0.666–1.000 (p<0.01) and the corresponding kappa statistic was 0.767–1.000 (p<0.01).

Six clinical parameters were evaluated by two calibrated clinicians (KK and PS) as follows:

1. Gingival phenotype was assessed using two methods.

1.1) Transparency probing

The evaluation was based on the transparency of the periodontal probe (CPU 15 UNC, Hu-Friedy, Chicago, IL, USA) through the gingival margin while probing the sulcus at the mid-facial aspect of the 4 incisors. If the outline of the underlying periodontal probe could be seen through the gingiva, it was categorized as thin; if not, it was categorized as thick[13] (Fig. 1).

1.2) Visual inspection

Gingival contour was categorized into 3 types: Thin-scalloped, Thick-flat, and Thick-scalloped gingiva[14], based on gingival curvature and morphology by visual assessment. Clinical photos of the upper anterior teeth were taken and evaluated to confirm the clinical findings.

2. Probing depth (PD)

A periodontal probe (CPU 15 UNC, Hu-Friedy, Chicago, IL, USA) was used to measure the PD to the nearest 0.5 mm at the mid-facial, mesio-facial, and disto-facial aspect of the four incisors.

3. Gingival recession (RE)

The distance between the free gingival margin and the cemento-enamel junction was measured at the mid-facial, mesio-facial, and disto-facial aspect of the four incisors using the same periodontal probe. A positive number was recorded if there was gingival recession.

4. Gingival width (GW)

This parameter was defined as the distance from the free gingival margin to the mucogingival junction. The same periodontal probe was used to measure at the mid-facial to the nearest 0.5 mm.

5. Papilla height (PH)

PH was defined as the distance from the top of the interdental papilla to a line connecting the mid-facial soft tissue margin of the two adjacent teeth. PH was assessed to the nearest 0.5 mm using the same periodontal probe at the mesial and the distal aspect of both central incisors (Fig. 2).

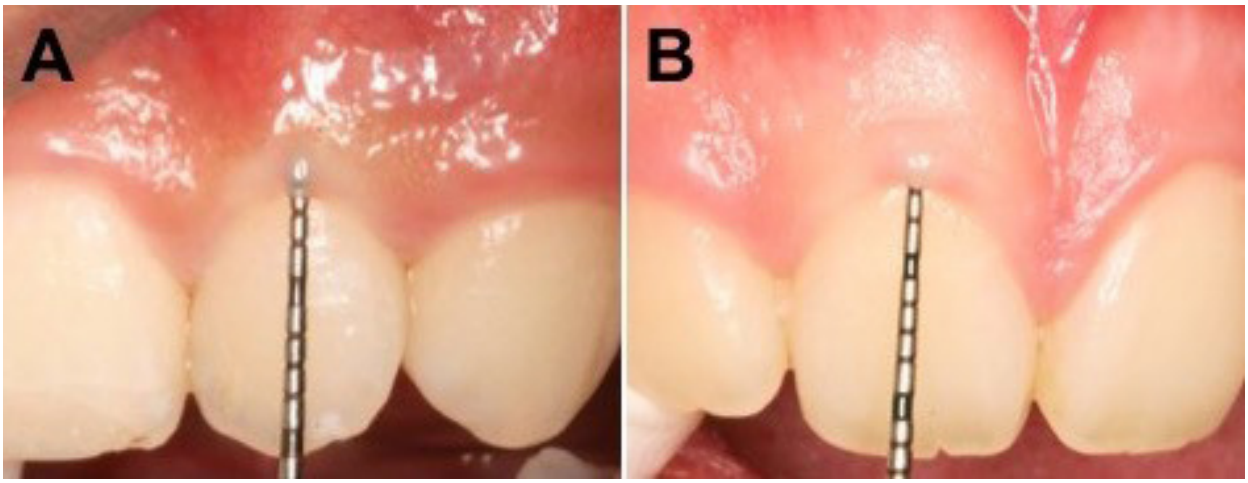

Figure 1 *Illustration of thin (A) and thick (B) gingival phenotype by transparency probing method.*

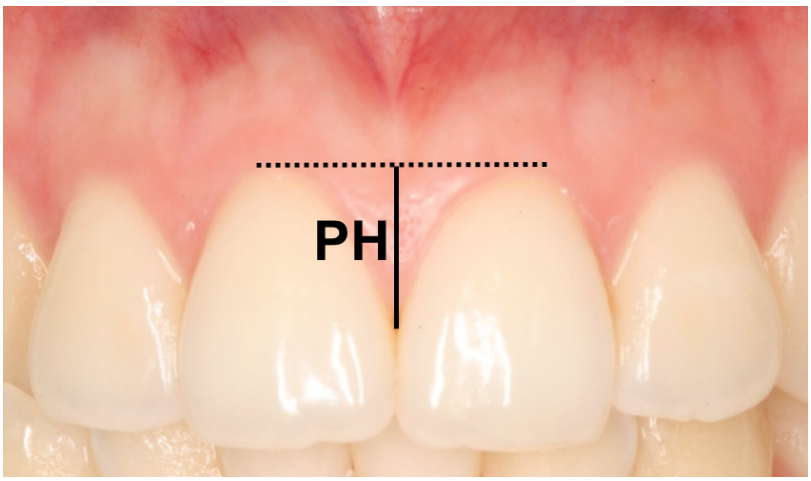

Figure 2 *Measurement of papilla height (PH).*

6. Tooth shape (TS)

Visual inspection was performed to categorize tooth shape[19] as follows:

- Square shape was defined as a tooth with parallel interproximal lines.

- Triangular shape was defined as a tooth with flared interproximal lines from the gingival margin to the incisal edge.

- Oval shape was defined as a tooth with interproximal lines that curved towards each other incisally and cervically.

Statistical analysis

The descriptive data; tooth shape, gingival phenotype of each tooth, was used to categorize each subject. The characteristics presented in most of their anterior teeth was used, otherwise, those of the central incisors were used.

Descriptive analysis was performed to determine the prevalence of gingival phenotype and tooth shape. Associations between gingival phenotype and gender and tooth shape were analyzed using the Chi-square test. The difference between clinical parameters and gingival phenotype was analyzed using the independent *t*-Test and ANOVA after testing for normal distribution with the Kolmogorov-Smirnov test (SPSS version 16, SPSS Inc., Chicago, IL, USA). A significance level of α = 0.05 was used.

Results

Based on the exclusion criteria, 100 periodontally healthy Thai dental students with 400 maxillary incisors were examined. The subjects comprised 42 males and 58 females with a mean age of 22.20±0.84 years.

The majority of the subjects (66 %) had thin gingival phenotype when assessed by probe translucency, and 42 % had a thin-scalloped gingiva contour. The same trend was also demonstrated in both central and lateral incisors (data not shown). There was no significant difference between gender and gingival phenotype (Table 1).

The periodontal parameters of the central (CI) and lateral incisors (LI) were similar (Table 2). There were no differences in mean PD and RE between thick and thin gingival phenotypes. However, the maxillary central and lateral incisors with a thick gingival phenotype had a significantly wider GW and lower PH compared with teeth with a thin phenotype (GW=5.51±1.10 vs. 4.84±1.21 mm; PH= 4.23±0.74 vs. 3.84±0.94 mm; $p \leq 0.01$). Moreover, subjects with thick-flat gingiva demonstrated a significantly lower PH than those with thick-scalloped and thin-scalloped gingiva (3.06±0.66 vs. 4.41±0.56 and 4.38±0.65 mm, respectively) ($p \leq 0.01$). A flat gingival contour was observed when the PH<4 mm in 90 % of the subjects while over 70 % of the subjects had a scalloped gingival contour when the PH was ≥4 mm (Table 1).

The prevalence of tooth shape when categorized into ovoid, square, and triangular teeth was 33 %, 38 % and 29 %, respectively. Ovoid and square tooth shape was the most common found in females (37.90 %), while square tooth shape was the most prevalent in males (38.10 %). There was no significant association between tooth shape and gender. However, a strong association between gingival phenotype and tooth shape was found (p<0.01). A thick gingival phenotype was associated with square and ovoid teeth, while a thin gingival phenotype was associated with square and triangular teeth. Significant associations were found between thick-flat gingiva and square teeth, thick-scalloped gingiva and ovoid teeth, and thin-scalloped gingiva and triangular teeth (Fig. 3, Table 3).

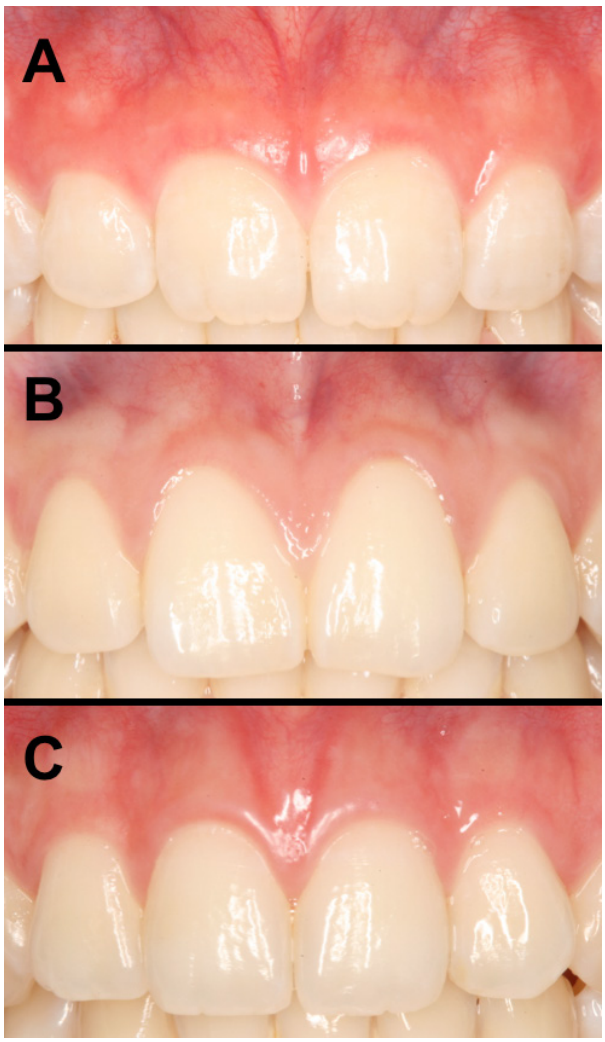

Figure 3 *Different tooth shape presented in different gingival phenotype. A) Square teeth with thick-flat gingiva. B) Triangular teeth with thin-scalloped gingiva. C) Ovoid teeth with thick-scalloped gingiva.*

Table 1 *Distribution of gender, gingival width, and papilla height according to gingival phenotype and gingival contour.*

	Gender		GW		PH	
	Male	Female	<5 mm	≥5 mm	<4 mm	≥4 mm
Gingival phenotype						
- Thick	17 (40 %)	17 (29 %)	7 (20 %)	27 (80 %)	21 (62 %)	13 (38 %)
- Thin	25 (60 %)	41 (71 %)	37 (56 %)	29 (44 %)	19 (29 %)	47 (71 %)
Gingival contour						
- Thick flat	8 (19 %)	15 (26 %)	2 (8 %)	21 (92 %)	21 (91 %)	2 (9 %)
- Thick scalloped	19 (45 %)	16 (27 %)	15 (43 %)	20 (57 %)	8 (23 %)	27 (77 %)
- Thin scalloped	15 (36 %)	27 (47 %)	27 (64 %)	15 (36 %)	11 (26 %)	31 (74 %)

Table 2 *Comparison of clinical parameters between gingival phenotype and gingival contour (mean (SD))*

	Gingival phenotype		Gingival Contour		
	Thick	Thin	Thick flat	Thick scalloped	Thin scalloped
PD (mm)					
CI	1.78 (0.40)	1.77 (0.30)	1.74 (0.37)	1.81 (0.39)	1.76 (0.25)
LI	1.76 (0.31)	1.82 (0.30)	1.80 (0.30)	1.83 (0.35)	1.80 (0.29)
RE (mm)					
CI	-1.70 (0.41)	-1.60 (0.53)	-1.62 (0.42)	-1.79 (0.41) †	-1.50 (0.57) ‡
LI	-1.70 (0.49)	-1.56 (0.49)	-1.67 (0.49)	-1.64 (0.49)	-1.54 (0.49)
GW (mm)					
CI	5.51 (1.10)	4.84 (1.21) **	5.96 (1.05)	5.11 (1.19) ††	4.54 (1.01) ‡‡
LI	5.48 (1.25)	4.82 (1.21) *	5.87 (1.21)	4.95 (1.10) ††	4.58 (1.10) ‡‡
PH (mm)					
CI	3.84 (0.94)	4.23 (0.74) *	3.06 (0.66)	4.41 (0.56) ††	4.38 (0.65) ‡‡
LI	3.35 (0.98)	3.83 (0.72) **	2.86 (0.76)	3.97 (0.64) ††	4.03 (0.61) ‡‡

* *significant difference between*	*thick&thin*	*P < 0.01*
** *significant difference between*	*thick&thin*	*P < 0.001*
‡ *significant difference between*	*thick flat&thin scalloped*	*P < 0.01*
‡‡ *significant difference between*	*thick flat&thin scalloped*	*P < 0.001*
† *significant difference between*	*thick flat&thick scalloped*	*P < 0.01*
†† *significant difference between*	*thick flat&thick scalloped*	*P < 0.001*

Table 3 *The relationship between gingival parameter and tooth shape.*

Gingival parameter		Tooth shape (%)		
		ovoid	square	triangular
Gingival phenotype	Thick	47.10*	41.20*	11.80
	Thin	25.80	36.40*	37.90*
Gingival contour	Thick flat	39.10	56.50*	4.30
	Thick scalloped	42.90*	31.40	25.70
	Thin scalloped	21.40	33.30	45.20*

** statistically significance (p<0.05)*

Discussion

The present study evaluated the prevalence and characteristics of gingival phenotype in Thai-young adults. We found that the majority of subjects presented with a thin gingival phenotype with scalloped gingival contour. The subjects were dental students who tended to have healthy periodontal condition and good oral hygiene practice. Assessment of gingival phenotype should be done only when the gingival tissue is not inflamed; otherwise, misinterpretation can occur.

There is wide variation in the definitions used to classify gingival phenotype. Some studies classified the phenotype based on gingival thickness into thick and thin phenotypes.[8,12,13] Other studies considered tooth morphology in addition to gingival morphology and thickness.[1,6,14] Currently, there is no consensus definition and categorization of gingival phenotype.[17] Thus, the term gingival phenotype was used in the present study and evaluated using two methods.

We found that 66 % of the subjects had thin gingival phenotype and thin-scalloped gingival contour. This result is different from those of previous studies which, overall, a thick gingival phenotype (51.90 %) was found more often compared with a thin phenotype, according to a systematic review.[17] Difference in prevalence of gingival phenotype between studies may be due to study criteria in the examination or survey. In the systematic review, entire anterior teeth and/or premolars were included in the analysis, while only maxillary incisors were evaluated in our study. However, the high prevalence of a thin-scalloped gingival contour in our study was similar to that of a previous investigation.[14]

No association between gingival phenotype and gender was found in our subjects, which is in agreement with other studies.[20,21] However, in Caucasians and Indians, a significant association was found between gender and gingival phenotype.[14,18] In these studies, male maxillary central incisors were associated with a thick gingival phenotype while those of females were associated with a thin gingival phenotype. The prevalence of a specific gingival phenotype may vary depending on ethnic genetic variations that impact tooth morphology and the periodontium.[18]

All subjects presented with a low PD, demonstrating healthy periodontal status. The mean GW of the upper incisors was 5.08±1.21 mm, which was similar to previous studies.[6,14,22] Thus, 5 mm GW was used to classify subjects in Table 1. GW represents the zone of keratinized gingiva which the greatest width usually found in the maxillary anterior region.[23] A wider zone of keratinized tissue width was significantly associated with a thick phenotype, while a narrower zone was significantly associated with a thin phenotype. This relationship has been noted in other studies.[6,14] Broad keratinized tissue zone in combination with a thick gingival phenotype may lead to the low incidence of gingival recession seen in those areas after nonsurgical periodontal therapy.[8]

Transparency probing, and visual assessment were used for gingival evaluation in our study. Transparency probing was originally used for determining the gingival thickness on the facial aspect of dental implants.[13] Subsequently, visual assessment was used as a simple method for clinical practice.[14] However, a significant difference between visual assessment versus transparency probing and direct measurement was demonstrated. Visual assessment always detected a thin phenotype when the gingival thickness was less than 0.6 mm, and a thick phenotype when the thickness more than 1 mm. When using transparency probing, a thin phenotype was detected if the gingival thickness was 0.6 mm while finding a thick phenotype when the gingival thickness was more than 1.2 mm.[12] The use of transparency probing provides a similar assessment compared to using direct measurement and thus, it is more reliable to evaluate gingival thickness compared with visual assessment.

We found that in both thick and thin gingiva, the PH seen in scalloped contour, which was usually >4 mm, was significantly higher compared with that of the flat type. It has been stated that a scalloped contour will be assessed when the PH is >4 mm.[24] In the present

study, the 4 mm PH was used to categorize patient to determine gingival contour and our findings supported the previous statement. This finding demonstrated that although visual assessment was accurate for categorizing the gingival contour as scalloped or flat, it is not accurate for determining gingival thickness. Therefore, we suggest that both methods should be used to analyze gingival morphology. Gingival thickness should be assessed by transparency probing and gingival contour should be determined by visual assessment. Measuring PH and using 4 mm as the break point should be used to determine the gingival contour leading to more accurate risk assessment.

Square tooth morphology was found the most in our subjects. Females tended to have square and ovoid tooth shape and males have square and triangular tooth shape, however no significant association between gender and tooth shape was found. Our results were different from another study that showed females were associated with triangular shape while males were associated with square tooth shape.[25] The ethnicities of the subjects between studies may explain these disparate findings.

The gingival contour affects the visual appearance of tooth shape. The association between gingival phenotype and tooth shape was shown in several studies.[1,6,14,26] Thick gingiva was associated with a square (short-wide) tooth shape and thin gingiva was associated with a tapered (long-narrow) tooth shape. We identified a scalloped contour in both thick and thin phenotypes in teeth where the interproximal lines converged cervically. Moreover, a previous study determined that a scalloped gingival contour was found along with slender teeth, regardless of gingival thickness.[14] In our study, tooth shape was classified into 3 types and each type was significantly associated with a different gingival contour. A thick-flat gingival contour was associated with square teeth, a thick-scalloped gingival contour was associated with ovoid teeth, while a thin-scalloped gingival contour was associated with triangular teeth.

In this study, we included subjects with no history of orthodontic treatment, because tooth position may affect the gingival phenotype. If the teeth are not in alignment in a facio-palatal position, different gingival thicknesses and tooth morphology may be present between teeth. This condition may result in different gingival phenotypes/contours seen between the left and right central and lateral incisors. Thus, representative characteristics needed to be determined at the subject level. The process used to determine the subject level characteristics was based on previous studies.[12,14]

The present study highlights the possible impact of ethnicity on teeth and soft tissue variations. Thai young adults tend to have a thin gingival phenotype and slender teeth, thus, may have higher esthetic risk after dental treatment. Clinicians should be aware of these differences to modify the patient's treatment plan accordingly to each individual. A future study may be conducted to determine gingival phenotype using ultrasound or CBCT in addition to the two gingival assessment methods used in our study to confirm the reliability of the assessment. A long-term esthetic risk assessment on maxillary anterior teeth should also be performed amongst different gingival phenotype.

Conclusions

A thin gingival phenotype with scalloped gingival contour was most commonly found in the maxillary incisors of this Thai-young adult group. A thin phenotype was associated with slender teeth, higher papilla height, and narrower gingival width, while a thick phenotype was associated with square teeth, less papilla height, and wider gingival width. Transparency probing in combination with visual assessment should be used for optimally evaluating the gingival phenotype. The identification of a scalloped gingival contour can be confirmed when the papilla height is > 4 mm. Gingival phenotype and contour should be determined in routine periodontal examination.

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