Int J Clin Exp Med 2018;11(11):12531-12538
www.ijcem.com /ISSN:1940-5901/IJCEM0077909

Original Article

Conjoint fascia sheath suspension for treatment of moderate to severe ptosis of the upper eyelid and observation of postoperative upper eyelid movement

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Received April 14, 2018; Accepted June 8, 2018; Epub November 15, 2018; Published November 30, 2018

Abstract: This study aimed to evaluate the effect of a combined fascia sheath (CFS) suspension for treating moderate to severe ptosis and analyze the effect of the two surgical methods on postoperative upper eyelid movement. A total of 150 patients with moderate to severe ptosis of the upper eyelid were included. The CFS suspension was used in the study group, while the frontal muscle flap suspension was used in the control group. The total effective correction rate was significantly higher in the study group than in the control group (94.67% vs 66.67%; $P < 0.001$). The range of upper eyelid movement and tear film distribution were significantly better in the study group than in the control group 1 week, 1 month, 3 months, 6 months, and 9 months after the operation ($P < 0.001$). The incidence of retardation and dysraphism of the upper eyelid was lower in the study group than in the control group ($P < 0.001$). The total incidence of complications was 6.48% vs 36.11% (study group vs control group). The incidence of complications in the study group was significantly lower than that in the control group ($P < 0.001$). The CFS suspension was more effective than the frontal muscle flap suspension for correcting moderate to severe ptosis, lifting the upper eyelid, and recovering upper eyelid movement. Its use can effectively reduce adverse reactions and complications, making it worthy of clinical application and promotion.

Keywords: Conjoint fascia sheath suspension, frontal muscle flap suspension, moderate-severe congenital ptosis, upper eyelid function

Introduction

The upper eyelid normally covers the superior 1-2 mm of the cornea. When this value exceeds 2 mm, ptosis may be diagnosed [1]. Congenital ptosis is a common clinical eyelid disease. The incidence in humans is about 0.12%, and cases can be divided into mild, moderate, and severe. Cases in which the ptosis degree is ≥ 4 mm, in which the upper eyelid covers about half of the pupil, are considered severe [2]. The main reason for the occurrence of ptosis are: failure of the upper eyelid to lift, partial or complete ptosis due to partial functional dysplasia and defects of the upper eyelid muscle, Müller smooth muscle, or nerve defects of the levator palpebral muscle [3]. Ptosis often results in partial or complete occlusion of the pupil and obstruction of sight. If it is not corrected in time, it may lead to deprivation amblyopia, which seriously affects visual function. Affected eyes will appear inactive, lax, lazy, and inferior [4, 5].

Surgical treatment of moderate to severe congenital ptosis involves a variety of methods, including levator palpebral shortening, frontal muscle flap suspension, good frontal muscle flap suspension, and fascia lata suspension [6]. Levator palpebral shortening is suitable for correcting mild to moderate ptosis (muscle strength of upper eyelid, > 5 mm), but for some patients with poor muscle strength of the upper eyelid, under correction or lack of efficacy is often observed. Even if most of the muscle

resection or folding migration is successful, palpebral fissure dysraphism is often induced [7]. The most commonly used surgical treatment for severe ptosis (muscle strength of upper eyelid > 4 mm) is frontal muscle flap suspension. However, this method has certain limitations, such as the frontal muscle flap suspension force appearing to be reduced or vanished over time to varying degrees, meaning that the recurrence rate is extremely high. Upper eyelid fallback is common and direct vision exposure is difficult, making it difficult to finish fine separation and hemostasis, causing adhesion scars in the surrounding tissues and an unsatisfactory effect of blepharoplasty or eyelid border shape postoperatively. Postoperative thread tension or congestion will cause inflammation in the surrounding tissues, resulting in the appearance of knot slip and scars [8, 9]. Therefore, it can reduce the occurrence of complications; trying to avoid the surgical oriented retardation or dysraphism has important clinical significance.

The conjoint fascial sheath (CFS) was first used by plastic surgeon Professor Holmstro to treat various congenital ptosis with great success [10]. To confirm the clinical application effect of conjoint fascial sheath suspension on moderate to severe congenital ptosis, this study used CFS suspension and frontal muscle flap suspension, respectively, to treat moderate to severe congenital ptosis. By observing upper-eyelid range of activity eyelid, tear film distribution, retardation of the upper eyelid, and eye closing ability, we can evaluate the effects of two different surgical methods on the upper eyelid movement status of patients with moderate to severe congenital ptosis. Here we aim to summarize our clinical experience with moderate to severe congenital ptosis.

Material and methods

General materials

A total of 216 eyes (150 patients) with moderate to severe ptosis of the upper eyelid were included. CFS suspension was used in the study group (75 cases; 108 eyes), while frontal muscle flap suspension was used in the control group (75 patients; 108 eyes). In the study group, there were 30 men (51 eyes) and 45 women (57 eyes) with a mean age of 21.6 ± 3.4 years (range, 18-35 years). There were 35 patients (50 eyes) with moderate ptosis and 40 patients (58 eyes) with severe ptosis. In the control group, there were 26 men (45 eyes) and 49 women (63 eyes), with a mean age of 22.1 ± 2.9 years (range, 19-33 years). There were 31 patients (48 eyes) with moderate ptosis and 44 patients (60 eyes) with severe ptosis.

Inclusion-exclusion criteria

Inclusion criteria included the following: diagnosis of congenital moderate to severe ptosis; Moderate palatal drooping: the epigastrium covers the cornea > 4 ~ ≤ 6 mm, sagging volume > 2 ~ ≤ 4 mm, severe ptosis: the corneal margin covers the cornea > 6 mm, the coverage reaches the center of the pupil, the sagging volume > 4 mm; positive Bell syndrome before surgery; no history of eyelid operation; and complete clinical data. This study received approval from our institute's Ethics Committee, the subjects and their families were notified of the study aims, and each subject provided written informed consent. Exclusion criteria included the following: neurosis with jaw-winking syndrome or ptosis signs; connective tissue disease or immune disease; other contraindications for eyelid surgery; severe heart, lung, liver, and kidney function or hematopoietic dysfunction; and family history of mental illness or psychosis.

Preoperative preparation

Blood circulation and vasodilator drugs were discontinued 2 weeks before surgery for patients in the study and control groups, antibiotic eye drops were banned 7 days before the surgery. We performed refractive and vision, exophthalmos, pupillary, eye movement, strabismus and diplopia, tear lamp, biomicroscopic, and thyroid function examinations.

Surgical methods

The frontal muscle flap suspension uses Meilan mark 5-6-mm double eyelid line as the surgical incision, with 2% lidocaine combined with a 1:100000 adrenaline for local anesthesia. The skin was cut and separate downward, cutting off 2 mm of the orbicularis oculi muscle of the tarsus and fully exposing the tarsus. An injection of 2% lidocaine was used to separate the upper orbicularis oculi muscle and interorbital septum and separate the layers to the junction of the frontalis and orbicularis oculi muscle. The frontal muscle flap muscle was clipped and

Table 1. Baseline data for study group and control group

Classification	Study group (n=75)	Control group (n=75)	t/x^2 value	*P* value
Gender			0.456	0.613
Male	30 (40.00)	26 (34.67)		
Female	45 (60.00)	49 (65.33)		
Age	21.6 ± 3.4	22.1 ± 2.9	0.969	0.334
Ptosis status			0.433	0.622
Moderate	35 (46.67)	31 (41.33)		
Severe	40 (53.33)	44 (58.67)		
Upper eyelid muscle strength	3.241 ± 0.039	3.245 ± 0.025	0.747	0.455
Ptosis degree	2.753 ± 0.834	2.596 ± 0.710	1.241	0.216
RBC ($\times 10^{12}$/L)	4.3 ± 0.4	4.2 ± 0.5	1.353	0.178
PLT ($\times 10^{9}$/L)	151.3 ± 31.7	159.1 ± 35.4	1.422	0.157
Hb (g/L)	134.1 ± 4.4	133.2 ± 4.2	1.281	0.202

turned over to separate the frontalis and the skin up to 1 cm above the eyebrow. The frontalis was opened using scissors to separate the upper and lower tissues, pulling the frontal muscle flaps, peeling off the frontalis and cutting both sides. This activates the frontal muscle flaps downward along with the use of absorbable thread to affix the frontal muscle flap to the tarsus.

We mattress-sutured the area using three needles and observed the upper eyelid position. The upper eyelid arch was adjusted to a satisfactory position. The eyelid was then sutured and smeared with oculentum erythromycin.

For CFS suspension, from the upper conjunctiva and upper eyelid subcutaneous, we injected infiltration anesthesia and designed the thread to cut off the subcutaneous tissue, cut off the anterior orbicularis oculi muscle of the tarsus, and fully exposed the tarsus edge. Then we lifted the orbital septum to remove the excess fat, separated it from the levator palpabrae muscle, separated the posterior orbital septum from the levator palpabrae muscle after exposure and injected 2% lidocaine into the conjunctiva, using water to separate the conjunctiva and Miller's muscles. The levator palpabrae muscle and Miller's muscle aponeurosis was separated 5 mm above the hole and the white thickened CFS tissue was exposed. Three needles were sutured in the CFS tissue at the external, middle, and internal sides. The CFS was pulled down and affixed to the superior border of the tarsus. The patient was told to stare straight ahead. We then observed the position of the upper eyelid; if it was not feasible, we adjusted it with the CFS position and the non-fixed tarsus until it was fixed at a height of 1-2 mm above the tarsus. From the segment of Miller's muscle, the upper eyelid muscle and muscle complex was sutured to the edge of the tarsus. The skin incision of the double eyelid surgery was then sutured and smeared with oculentum erythromycin.

Postoperative treatments

The eyes were fixed and pressure-wrapped for 36 hours. If patients had dysraphism of the eyes after surgery, we sutured it in time to raise the lower eyelid to close the eyes and covered them with a dressing. We changed the drug daily after surgery, observed whether the cornea was dry, applied oculentum erythromycin to the conjunctival sac at night, and removed the double eyelid line after 7 days.

Observation index and assessment

Correction satisfaction was based on the ptosis correction criteria proposed [11]. Postoperatively, the patients were observed for palpebral fissure height, upper corneal mass, and corneal exposure. A satisfactory grade was considered as follows: The upper eyelid border was located at 1 mm from the corneal limbus. The arc of the upper eyelid was natural and the eyelids were symmetrical. An acceptable grade was as follows: The eyelid border was located between 1 mm above the superior border of the cornea and 2 mm below the corneal limbus. The arc of the double eyelids was natural. The ptosis correction was acceptable. An insufficient grade was as follows: The upper eyelid

Table 2. Comparison of treatment effect between study group and control group [n (%)]

Group	Satisfactory	Acceptable	Insufficiency	Overcorrection	Total effective rate of correction
Study group	63 (84.00)	8 (10.67)	4 (5.33)	0 (0.00)	71 (94.67)
Control group	39 (52.00)	14 (18.67)	11 (14.67)	11 (14.67)	50 (66.67)
x^2 value			21.550		18.852
P value			P < 0.001		P < 0.001

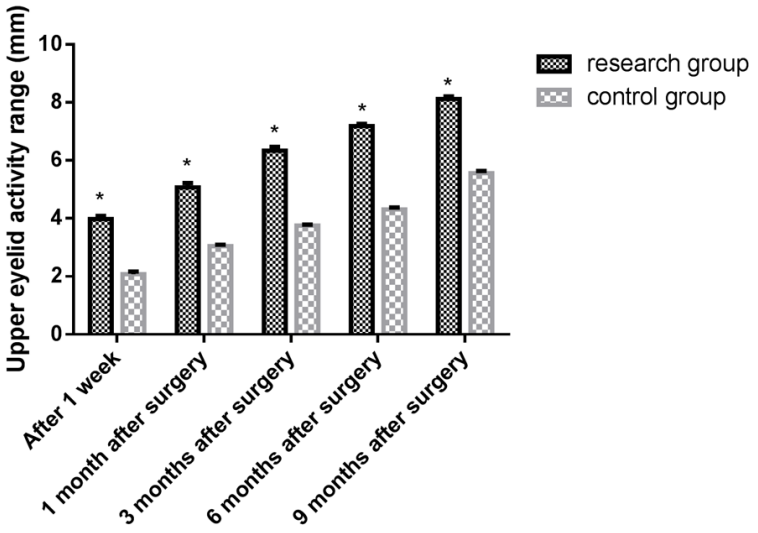

Figure 1. Comparison of the results of the range of upper eyelid movement between the study and control groups. The results show that the range of upper eyelid movement in the study group was significantly better than that in the control group (P < 0.001). *P < 0.001 compared with the control group.

border was located at the 2-mm point of the cornea when the patient was looking straight ahead, under corrected if at 1 mm, and over-corrected if > 2 mm above the superior border of the cornea. The total effective rate was (satisfactory + acceptable)/total number of cases × 100%.

The range of upper eyelid activity and the levator palpabrae muscle strength of the preoperative conditions are the same. The patient looked down and squeezed the area of the eyebrow arches to block the contraction force of the frontalis. The ruler was placed on the lowest part of the upper eyelid border. The patient looked naturally upward, observed the ruler scale change, and the value on the ruler was the range of activity of the upper eyelid.

Distribution of tear films is based on the previous report [12]. An eye examination was performed using 1% sodium fluorescein eye drops, the patient blinked, and then the distribution of tear film was observed. The time of film rupture of the membrane was recorded. A BUT value ≤ 5 seconds was poor, indicating an uneven tear film distribution; a BUT value < 5 seconds was acceptable, indicating that the tear film was evenly distributed; a value of 5 seconds < BUT ≤ 10 seconds was good, indicating that the tear film was well distributed; and a BUT > 10 seconds was excellent, indicating that the tear film was very well distributed. The statistics of excellent and good percentage of the total number of cases will be compared between the two groups.

Dysraphism and retardation of the upper eyelid were divided into positive and negative cases according to whether the patient's eye had dysraphism and retardation of the upper eyelid. The dysraphism and retardation of the upper eyelid were positive, while the normal was negative. The percentage of positive patients was counted.

Postoperative follow-up visits of the study and control groups were conducted at 1 week, 1 month, 3 months, 6 months, and 9 months after the surgery. Each patient's activity range of upper eyelid, tear film distribution, dysraphism and retardation of the upper eyelid were observed and recorded. The same physician observed the occurrence of postoperative complications, calculated the incidence of complications, and determined and recorded the motor function.

Statistical methods

SPSS v. 17.0 was used for the statistical analysis. Measured data are expressed as mean ±

Table 3. Comparison of tearfilm distribution between study and control groups, n (%)

Group	N	After 1 week	1 month after surgery	3 months after surgery	6 months after surgery	9 months after surgery
Research group	108	41 (37.96)	63 (58.33)	105 (97.22)	108 (100.00)	108 (100.00)
Control group	108	0 (0.00)	18 (16.67)	48 (44.44)	81 (75.00)	93 (86.11)
x^2 value	-	50.606	40.000	72.807	30.857	16.119
P value	-	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001

Table 4. Comparison of retardation rate of patients in study and control groups, n (%)

Group	N	After 1 week	1 month after surgery	3 months after surgery	6 months after surgery	9 months after surgery
Research group	108	75 (69.44)	35 (32.41)	10 (9.26)	2 (1.85)	0 (0.00)
Control group	108	106 (0.00)	79 (73.15)	63 (58.33)	51 (47.22)	46 (42.59)
x^2 value	-	32.767	35.963	58.123	60.032	58.447
P value	-	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001

Table 5. Comparison of incomplete closure of the palate of patients in study and control groups, n (%)

Group	N	After 1 week	1 month after surgery	3 months after surgery	6 months after surgery	9 months after surgery
Research group	108	81 (75.00)	39 (36.11)	13 (12.04)	0 (0.00)	0 (0.00)
Control group	108	107 (0.00)	103 (95.37)	73 (67.59)	32 (29.63)	11 (10.19)
x^2 value	-	27.739	84.196	69.553	37.565	11.590
P value	-	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001

standard deviation ($\bar{x} \pm s$). The Chi-square test was used for inter-group enumeration data, while the t-test was used for inter-group measurement data. Values of $P < 0.05$ were considered statistically significant.

Results

Patient baseline data by group

There were no significant differences in clinical data between the study and control groups in terms of sex, age, ptosis status, upper eyelid muscle strength, ptosis degree, red blood cell (RBC) count, platelet (PLT) count, or hemoglobin (Hb) level (P > 0.05) (**Table 1**).

Therapeutic effect of study and control groups

In the study group, 63 cases were satisfactory, eight were acceptable, four were insufficient, and none were overcorrected. The total effective rate was 94.67%. In the control group, 39 cases were satisfactory, 14 were acceptable, 11 were insufficient, and 11 were overcorrected. The total effective rate was 66.67%. The correction rate of the study group was significantly higher than that of the control group (P < 0.001) (**Table 2**).

Observation of postoperative upper eyelid movement in study and control groups

At 1 week, 1 month, 3 months, 6 months, and 9 months after the operation, the range of upper eyelid movement in the study group was significantly better than that of the control group (P < 0.001). The distribution of tear film in the study group was significantly better than that of the control group (P < 0.001). The occurrence rate of the upper eyelid retardation in the study group was less than that of the control group (P < 0.001) and the occurrence rate of the upper eyelid dysraphism in the study group was less than that of the control group (P < 0.001) (**Figure 1**; **Tables 3**-**5**).

Incidence of postoperative complications in study and control groups

In the study group, there was one patient with conjoint exposure keratitis, three with hematoma in the eyebrow area, one with entropion, and two with conjunctival prolapse. The total

Table 6. Comparison of incidence of postoperative complications between study group and control group, n (%)

Group	N	Exposure keratitis	Eyebrow area hematoma	Upper eyelid entropion	Conjunctival prolapse	Total incidence
Research group	108	1 (0.93)	3 (2.78)	1 (0.93)	2 (1.85)	7 (6.48)
Control group	108	8 (7.41)	12 (11.11)	9 (8.33)	10 (9.26)	39 (36.11)
x^2 value	-	5.681	5.803	6.711	5.647	28.284
P value	-	0.035	0.029	0.019	0.033	P < 0.001

incidence of complications was 6.48%. In the control group, eight had conjoint exposure keratitis in the control group, 12 had hematoma in the eyebrow area, nine had entropion, and 10 had conjunctival prolapse. The total incidence of complications was 36.11%. The incidence of complications in the study group was significantly less than that in the control group (P < 0.001) (**Table 6**).

Discussion

Ptosis is commonly encountered in departments of ophthalmology and plastic surgery. Ptosis has a certain influence on appearance and vision, and surgical correction is the best method of treating the disease in clinical practice. The ideal surgical effect not only makes the eyelid look natural when the patient blinks. Frontal muscle flap suspension is the most commonly used surgical method correcting ptosis. This kind of surgery can improve the physiological power of the upper eyelid and achieve better therapeutic effects, but it also has obvious defects. Some patients with poor upper eyelid muscle strength often have problems such as insufficient correction or even ineffectiveness. A series of complications tends to occur after the operation. The eyelids exercise ability is weak, activity is poor, and appearance is uncoordinated, which not only affects the patient's self-confidence, it leads to dry eyes and irritation similar to that of a foreign body, and severe cases can lead to exposed keratitis [13-15].

The CFS is a muscular sheath between the superior rectus and upper eyelid muscle located in the dome. It is a relatively independent connective tissue structure with a clear boundary. It is rich in elastic fibers and dominated by the oculomotor nerves. Therefore, CFS suspension is theoretically better than frontal muscle flap suspension in terms of physiological mechanics and anatomy [8, 16]. The results of this study showed that the effective rate of correction in the study group (CFS) was significantly higher than that of the control group (frontal muscle flap). The incidence of complications in the study group was significantly lower than that of the control group, suggesting that CFS suspension is more effective than the frontal muscle flap suspension in the treatment of moderate to severe ptosis and can effectively reduce the incidence of complications. Our analysis suggests that CFS main resource is in the superior rectus muscle. The CFS suspension also increases the superior rectus power and upper eyelid lifting power while maintaining upper eyelid muscle function. The contraction direction of the superior rectus muscle is consistent with that of the upper eyelid. Compared to frontal muscle flap suspension, CFS suspension conforms more to the characteristics of levator palpebrae superioris. It can alleviate deepening of the forehead wrinkles and eyebrow raising. It also benefits the coordinated movements and eyelid blinking. Upper eyelid correction can be achieved while the swelling and thickened effect of frontal muscle flap suspension is also avoided, making double eyelids more natural in appearance.

After a ptosis operation, it is often necessary to maintain a good movement state and coordinate the eye movements so that the eyelids are naturally beautiful. The results of this study showed that the range of upper eyelid movement in the study group was significantly better than that in the control group, suggesting that patients treated with CFS suspension have better upper-eyelid mobility. We analyzed that CFS has long been proven to be elastic fascial tissue in human anatomy. In the surgery, the upper eyelid muscle muscles can be combined with the tarsus. The scope of surgical separation is small, and the orbicularis oculi muscle and surrounding tissues are damaged less,

meaning that the patient closes his eyes with less resistance [14]. The frontal muscle flaps have less elastic fibrous tissue, and the downward extension of the elasticity is limited. The surgical separation is large, and the orbicularis oculi muscle and surrounding tissues are more damaged, making it easier to form adhesions, and the patient closes his eyes with more resistance [17]. Controversy persists regarding the power source of the CFS suspension. Some scholars believe that the source of eyelid muscle strength is the levator palpabrae muscle [18], while others believe that it is the superior rectus muscle [19]. The results of this study showed that patients in the study group had a lower incidence of dysraphism and retardation of the upper eyelid than those in the control group, but a few patients experienced postoperative motion pain and under correction. Our analysis suggests that it may be an inflammatory reaction induced by foreign matter stimulation in the superior rectus during surgery. After effective treatment, the upper eyelid border gradually returns to its normal position and the pain related to upper-eyelid movement disappears. Therefore, the power source of CFS suspension may be the synergistic effect of the superior rectus and the levator palpabrae muscle. When the eyeball is rotated up and down, the upper eyelid can be moved with the eyeball, a phenomenon that is consistent with the physiological characteristics of the upper eyelid movement, leading to a lower incidence of dysraphism and retardation of the upper eyelid and better coordination between the eyeball and the upper eyelid.

The blinking action distributes the tears evenly over the cornea and the tear film, thereby ensuring sufficient moisture in the cornea and tear film of the eye and maintenance of the physiological stability of the tear film [20]. The results of this study show that the distribution of tear film in the study group is significantly better than that in the control group, suggesting that tear film distribution was better in patients after CFS, who had less dry eye and a faster recovery. The activity of patients after CFS often determines the tear film distribution. The early establishment of blinking action can effectively prevent dry eye, fatigue, discomfort, and disturbance, leaving the eye in a relatively relaxed and comfortable situation. Under the natural complete circumstances of blinking and maintenance of eye agility, conform to the aesthetic demand of patients with moderate to severe ptosis and broad masses. Ahn et al. [10] showed a CFS suspension and levator palpabrae muscles shortening were adopted to treat congenital ptosis. CFS suspension had a higher positive correction than the levator palpabrae muscle shortening with less traumas to the eye, better improvement in eyelid movement, and fewer complications. Zuo et al. [8] showed that treating patients having recurrent severe ptosis with CFS suspension and frontal muscle flap suspension can improve the correction rate and reduce the incidence of adverse reactions. This is similar to the results of this study. The difference is that this study did not combine the use of the two treatment methods. It is not yet known whether the combination of the two surgical methods is applicable to patients with moderate to severe ptosis. Therefore, further observations are needed.

There was no difference in general clinical data such as sex, age, ptosis status, upper eyelid muscle strength, ptosis degree, RBC, PLT, and Hb between the study and control groups, which ensured the reliability of the study results. Compared to the traditional frontal muscle flap suspension to correct ptosis, CFS suspension does not destroy the original anatomic characteristics of the eyelid and results in small surgical trauma and mild postoperative adverse reactions. It can effectively restore eyelid motor function. It has profound significance for patients with moderate to severe ptosis. In this study, some patients with moderate to severe ptosis had different degrees of fallback after CFS suspension. Some adverse reactions and complications also occurred. Therefore, we hope that a more effective surgical method can be found in a future study.

In summary, compared to frontal muscle suspension, CFS suspension can effectively enhance the correction ratio of patients with moderate to severe ptosis and improve upper eyelid position. The recovery of upper eyelid motor function is better after surgery, which can effectively reduce adverse reactions and the incidence of complications. Thus, this finding is worthy of clinical application.

Disclosure of conflict of interest

None.

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