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White spot lesion and orthodontic treatment

A Project Submitted to

The College of Dentistry, University of Mosul, Department of Orthodontics in Partial Fulfillment for the Bachelor of Dentistry

By

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Certification of the Supervisor

I certify that this project entitled "White spot lesion and orthodontic treatment" was prepared by the fifth-year student Omar Imad Mohammed under my supervision at the College of Dentistry/University of Mosul in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry.

Supervisor's name

Lect. Rasha Yahya Al-Darzi

Date 17/2/2025

Dedication

I dedicate this work to my father, my mother and everyone who taught me and helped all over the past 20 years in my life.

Acknowledgment

Thank to ALLAH, the most giving and the most forgiving for everything given to me and for blessing me.

I would like to express grateful thanks to Dean of College of Dentistry, University of Baghdad Dr. RAYAN SALIM

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Introduction:

The term "white spot lesion" (WSL) is defined by (Fejerskov, et al., 2003) as "the first sign of caries lesion on enamel that can be detected with the naked eye" and is used alongside the terms "initial" or "incipient" lesions. Enamel decalcification in the form of white spot lesions is a common negative sequel of orthodontic treatment in the absence of proper oral hygiene. They appear as small lines along the bracket periphery and in a few patients as large decalcifications with or without cavitations. The presence of white spot lesions after removal of orthodontic appliances is a discouraging finding to a specialty whose goal is to improve facial and dental aesthetics. Clinically, formation of white spots around orthodontic attachments can occur as early as
4 weeks into treatment and their prevalence among orthodontic patients ranges from 2% to 96%. The labio-gingival area of the lateral incisors is the most common site for WSL and the maxillary posterior segments are the least common site, with males affected more in comparison with females (Joshua, et al.,2010).

Tufekci, et al.,2011 concluded in his clinical study that a sharp increase in the number of WSLs occurred during the first 6 months of treatment and continued to rise at a slower rate to 12 months, thus in the initial months of the treatment critical evaluation of oral hygiene is recommended . Mizrahi, et al.,1982 in a study using the opacity index scoring system, showed that the incidence and severity of white spot lesions occurred on both the labial and the lingual surfaces of teeth. There was a significant increase in the prevalence on the cervical and middle thirds of the crowns.

Definition of white spot lesions:

Subsurface enamel demineralizations are known as white spot lesions (Fig.1), and they represent the early phase of caries formation (Derks et al., 2004; Bergstrand and Twetman, 2011). Prevalence of WSLs is relatively high, affecting more than 25 per cent of the patients receiving orthodontic treatment, acquiring at least one new lesion during treatment (Hadler-Olsen et al., 2012; Lucchese and Gherlone, 2013). Demineralization may take place rapidly, as fast as within 4 weeks after the placement of brackets and can stay present even years after treatment (Bergstrand and Twetman, 2011). Clinically, surfaces are intact when gently probed in early phases. However, cavitation may occur if the cariogenic challenge is ongoing, which might lead to the necessity of invasive restorative treatments (Derks et al., 2004; Bergstrand and Twetman, 2011).

Fig 1 . White spot lesion

Fig 2 . White spot lesions after 14 months of orthodontic treatment with fixed appliances

Aim of study

Aims of study

The aims of this study was to assess the white spot lesions in orthodontic patients and how to manage this problem.

Chapter one: Review of literature

Relationship Of White Spot Lesion In Orthodontic Treatment

1.1 Incidence of white spot lesions:

Despite there are differences between the studies, the most affected teeth examined are upper lateral incisors, upper canines, lower canines and lower first molars, respectively (Gorelick L et al., 1982)

1.2 Prevalence of White Spot Lesions and Risk Factors:

Clinically, WSLs might develop rapidly, appearing on the 4th week after initiating treatment in the presence of poor oral hygiene.(Chapman JA et al, 2010)These decalcifications have been reported to be more common in patients undergoing fixed orthodontic treatment. However, their frequency has been reported to be widely variable, from 2% to 97% in different epidemiological studies,(Bishara SE, Ostby AW 2008)which might be explained by the techniques used to detect and characterize them, including visual inspection, photographs, fluorescent methods, and optical modalities such as diagnodent, quantitative light-induced fluorescence, and digital image fiber-optic transillumination(Pretty IA,2006) Methods using quantitative laser techniques are more sensitive, yielding a higher prevalence rate than the simple visual technique. On average, such decalcifications are found in 15.5%–40% of patients before orthodontic treatment and in 30%–70% during the treatment(Julien KC, et al 2013)Based on a recent meta-analysis, in the 14 studies evaluated for WSLs, the incidence rate of new carious lesions that developed during orthodontic treatment was 45.8%, with a prevalence rate of 68.4% in patients under orthodontic treatment. It was concluded that the incidence and prevalence rates of WSLs are quite high and alarming in patients receiving orthodontic treatment, necessitating the attention of both

patients and caregivers to effective caries prevention measures.(Sundararaj D,et al , 2006)

Therefore, before undertaking orthodontic treatment, these lesions should be diagnosed and recorded by means of standardized photographic plates, taking into account magnification, exposure time, lighting, etc(Bishara SE, Ostby AW , 2008) WSLs before orthodontic treatment are considered a risk factor for the development of new lesions,(. Heymann GC, Grauer D. A 2013) with poor oral hygiene, excessive drinking, frequent use of fermentable carbohydrates, excess bonding, long etching time (>15 s), decayed/treated molars, and the duration of treatment being considered other risk factors.

1.3 Classification of white spot lesions:

(Gorelick . et al., 1982) developed a system for scoring clinically visible white spot lesions (FiG 2). After drying the teeth with air, the lesions were given the following scores:

1, no clinical white spot lesions 2, minor white spot lesions; 3, severe white spot lesions; and 4, white spot lesions with cavitation. This method is widely used, and the score is related to the area of the lesion.

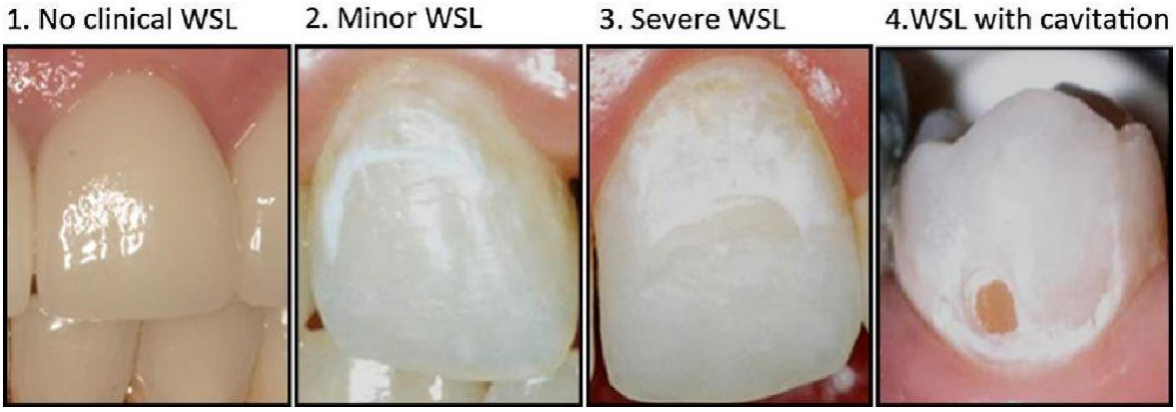

Fig 3 . A system for scoring clinically visible white spot lesions developed by(Gorelick. et al.,1982)

Another classification is the International Caries Detection & Assessment System (ICDAS) classification, which is created by combining the most successful features of all detection and evaluation systems used in the detection of caries by Ekstrand. et al.,1995. Although we started to understand the formation of caries and the influencing factors, over the years, it was clear that ICDAS I was inadequate in evaluating the lesion activity. Therefore, ICDAS I was modified in 2004, and ICDAS II was launched (Pitts. et al., 2004).

In ICDAS II, radiographic images of enamel and dentin lesions are also included in the classification. It is divided into five classes as follows:

E1: Lesion that reaches the outer half of the enamel

E2: Lesion that has advanced to the inner half of the enamel

D1: Lesion that is limited to the outer one-third of the dentin

D2: Lesion that has advanced to the middle third of the dentin

D3: Lesion that has advanced to the inner one-third of the dentin

1.4 Diagnosis of white spot lesions:

Nowadays, the importance of diagnosing carious lesions before they turn into irreversible cavitations has been understood. Most dentists have difficulty in deciding when to apply preventive methods and when to intervene. Evaluation of the patient's caries activity is also important in the diagnosis and treatment plan. White spot lesions in a caries-active mouth can quickly turn into cavitation's. However, in people with low caries activity, the repair mechanisms will be more effective; therefore, the lesions may have the potential of healing. Hence, it is important to plan the treatment according to the caries activity in individuals after a correct diagnosis (Zero , et al.,1999). The most commonly used diagnostic methods are listed next.

1.4.1 Visual Examination

The most used diagnostic method in the daily routine of dentists is visual examination (Axelsson . et al.,2000). It can be determined if a lesion is active or inactive by a visual examination of white spot lesions. Chalky and rough surfaces indicate that the lesion is active, while smooth and shiny surfaces are indicative of an inactive lesion (Zandona , et al.,2006).

1.4.2 Evaluation with Digital Photography

The conventional visual inspection does not provide a physical/numerical record of the teeth examined. Using a method for remote discussions, such as photography, could bring about a substantial improvement in dental education and case discussion. One would be able to discuss clinical situations at a distance by sharing the examination results with professionals based at different locations. Health services are gradually adopting this concept in telemedicine and teledentistry initiatives, with encouraging results, especially in educational and diagnostic applications (Kohara , et al.,2018). Digital dental photography is a field that requires technical sensitivity and education, considering the dark, small, and moist mouth environment as well as the interaction of soft and hard tissues with light. Along with the training, it is recommended to use a light system, such as lateral twin flash or ring flash, and a camera that allows macro lens and lens replacement. The disadvantages of these equipments are that they are big and heavy and their cost is high. However, these disadvantages can be eliminated, thanks to the camera and photo shooting features of smart phones, which have become very popular today (Estai , et al.,2017).

1.4.3 Fluorescence Techniques

The auto fluorescence feature of the enamel decreases because of demineralization. These optical changes are directly related to the mineral content of the enamel (Abufarwa , et al.,2018). Therefore, autofluorescence principle is used in early caries diagnosis to show mineral loss.

1.4.4 Quantitative light-induced fluorescence (QLF)

Generally, light spreads much faster in carious lesions than healthy dental tissues. Therefore, light absorption and fluorescence in the region of carious lesions is decreased. In this way, light emission measures can be used to evaluate the mineral loss. QLF technique works on this principle of fluorescence (Yılmaz , et al.,2018).

In recent years, FluoreCam (Therametric Technologies, Inc., Noblesville, IN, USA), a portable device that operates on the QLF principle, is available which is easier to use and carry. It stimulates the tooth surface with intense light and analyzes the resulting fluorescence image with its special software. As a result of the evaluation, three numerical data appear, indicating the size, density, and effect of the demineralized enamel lesion. There is no need for a darkroom as in case of QLF device while measuring, which makes it easier to use (Korkut , et al.,2017).

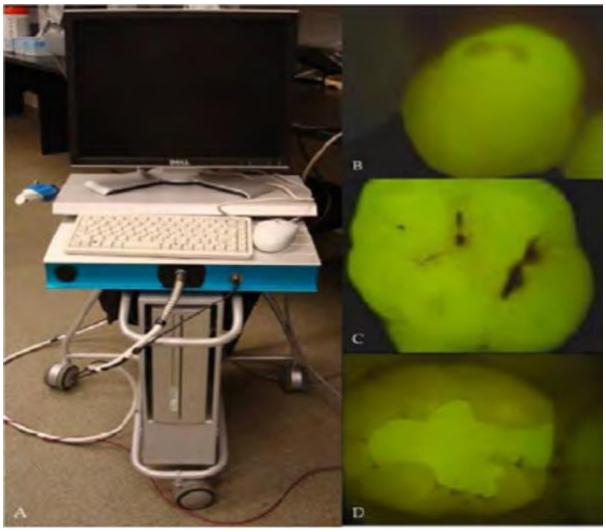

Fig 4. (A) QLF system. (B) Fluorescence image of an enamel caries lesion on the buccal surface. (C) Fluorescence image of an occlusal caries lesion. (D) Fluorescence image of a secondary caries lesion around a composite restoration

1.4.5 Laser Fluorescence

The DIAGNOdent pen has been developed for early diagnosis of carious lesions on occlusal and flat surfaces of teeth. This device emits a visible light of 638–655 nm wavelength using a diode laser, which is absorbed by organic and inorganic substances in the tooth structure, thereby the structures creating infrared fluorescence photons (Fekrazad , et al.,2019).

The filtered fluorescence signals are collected with a different fiber bundle at the same tip that emits the light and are shown by a photodiode with scores from 0 to 99. The density of the recovered photons is directly related to the depth of the lesion. Scores greater than or equal to 20 and 25 indicate the presence of carious lesions. Higher values indicate greater caries penetration depth (Fekrazad , et al.,2019). Rodriguez et al. 2017, reported that while the laser fluorescence method was effective in detecting the first demineralization in enamel, it was not effective in monitoring the progress of the lesion and was found insufficient to measure small changes in the mineral content. To improve this situation, the idea of examining the initial enamel lesion with laser fluorescence method after dying the lesion with a fluorescent dye was born and found successful (Fekrazad , et al.,2019).

The SoproLife camera is a modern caries detection method, based on laser induced fluorescence. This new method combines the advantages of visual examination, through a high magnification oral camera, and those of a laser fluorescence device (Terrer, et al.,2009; Raskin, et al.,2010). Kockanat and Unal.et al 2017 reported that SoproLife camera and ICDAS II showed the highest sensitivity values against other tested detection methods.

1.5 Evaluation of white spot lesions:

Accurate and rapid evaluation of white spot lesions during orthodontic treatment is very important for performing protective, preventive and corrective therapies Assessment of white spot lesions requires two steps. The first step involves evaluation of decalcification and the second step involves evaluation of severity of a lesion. Severity is assessed according to the brightness and size of a discoloration macroscopically, whereas according to the amount of mineral loss and lesion depth microscopically (Benson P 2008).

Etiology of white spot lesions:

White spot lesions are areas of demineralized enamel that usually develop because of prolonged plaque accumulation. Fixed orthodontic appliances create stagnation areas for plaque and make tooth cleaning difficult. The irregular surfaces of brackets, bands, and wires limit the naturally occurring self- cleansing mechanisms of the oral musculature and saliva (Mount, et al., 2005). This encourages plaque accumulation and the colonization of aciduric bacteria; over time, this results in active white spot lesions, and, if not treated, a cavitated caries lesion can develop White spot lesions can occur on any tooth surface in the oral cavity where the microbial biofilm is allowed to develop and remain for a period of time. Also impacting their development are the patient's modifying factors, including medical history; dental history; medication history; diet; levels of calcium, phosphate, and bicarbonate in saliva; fluoride levels; and genetic susceptibility. (Mount, et al., 2005 ; Chalmers, et al., 2006)

Chapter two: Prevention and Management of White Spot Lesions

Prevention and Management of White Spot Lesions:

WSLs should be managed using a multifactorial approach. The most important strategy is to prevent demineralization and biofilm formation, and use of methodologies for remineralization of lesions, thinning, microabrasion, erosion-infiltration, adhesive composite resin restorations, and, the bonded facets. (Morrier , et al.,2014)

2.1 Oral hygiene control

Prevention should first begin by educating and motivating the patient for compliance with a noncariogenic diet and observation of oral hygiene. Effective oral hygiene is the bedrock of prophylactic measures in fixed orthodontic patients. Mechanical plaque control and removal by proper brushing of the tooth surfaces, at least twice daily, with fluoride-containing toothpaste, especially in biofilm retention areas, is strongly recommended. During the recall visits, patient motivation should be reevaluated and if deemed necessary, the tooth surfaces should receive a professional cleaning and oral hygiene and dietary instructions should be repeated (Sudjalim , et al.,2006 ; Sangamesh , et al.,2011)

Use of a power toothbrushes or daily irrigation with water in association with manual tooth brushing might prove more effective in decreasing accumulation of plaque compared to manual toothbrushing alone (Harvey , et al.,1981).Professional prophylactic cleaning reduces the bacterial load, increases the efficacy of brushing, and facilitates cleaning by the patient. Professional tooth cleaning two or three times a year helps maintain a healthy mouth, decreasing the risk of dental caries and the number of teeth with carious lesions. Fluoridated pastes with progressively finer particle sizes can be used to polish coronal surfaces; furthermore, elastomeric polishing cups or

brushes help prevent mechanical retention of bacteria .Along with the brushing frequency, patient age, time past from appliance removal, length of treatment, type of the tooth (central or lateral incisor), and WSL surface area had also affect WSL improvement (Kim , et al.,2016).

2.2 Fluoride products

The favorable role of fluoride in preventing WSL has been documented with the use of the following: fluoride mouthwashes, fluoride gels, fluoride toothpastes, fluoride varnishes, fluoride in bonding agents, and fluoride in elastomers. The fluoride ion prevents dental caries, by modifying bacterial metabolism in dental plaque through inhibition of some enzymatic processes, by inhibiting production of acids by altering the composition of bacterial flora and/or the metabolic activity of microorganisms, and by decreasing demineralization and promoting remineralization of carious lesions at early stages through a remineralization effect, especially at low concentrations (Davidson , et al.,1980).

2.2.1 Fluorinated toothpastes

The fluoride concentration of toothpastes (in the form of sodium fluoride, monofluorophosphate, stannous fluoride) should be over 1000 ppm; toothpastes with higher fluoride concentrations are most effective (Marinho , et al.,2009; Chapman , et al.,2010).The use of a dentifrice with a high fluoride concentration (5000 ppm), twice daily, by patients at high risk for WSL is more effective than conventional formulations (Al-Mulla ,et al.,2010; Feng , et al.,2013) ; however, such a toothpaste (Duraphat) cannot be prescribed for patients under 16 years of age. Heymann and Grauer et al.,2013 recommend this toothpaste for brushing in the evenings only. Nonetheless, use of a fluoride toothpaste alone is not effective in preventing WSL in the majority of patients, even with good oral hygiene (Richter , et al.,2011).Therefore, it is recommended that other fluoride sources be used (Bishara , et al.,2008). Fig.3.

Fig 5 . Treatment of WSL was by tooth brushing and fluoridation, only. (A) WSLs and characteristical hyperplastic, swollen gingiva directly following de-bonding, (B) fifteen months later.

2.2.2 Fluoridated mouthwashes

Daily use of fluoridated mouthwashes containing sodium fluoride has been shown to result in a significant decrease in the development of carious lesion around and beneath bands. Antibacterial agents have been incorporated into these mouthwashes, including chlorhexidine, triclosan, or zinc to promote their cariostatic effects (Zabokova-Bilbilova , et al.,2014).Benson carried out a systematic review and recommended the daily use of 0.05% NaF mouthwash to prevent enamel demineralization during fixed orthodontic treatment (Benson PE, et al.,2003).A daily mouthwash containing NaF (0.05% or 0.2%) and/or weekly rinse containing alpha-1-fetoprotein (1.2%) have been demonstrated to decrease the incidence of enamel demineralization during fixed orthodontic treatment..

2.2.3 Fluoride varnishes

Fluoride varnishes (2–4 applications yearly) have proved effective in decreasing the incidence of caries in both deciduous and permanent dentitions (Marinho , et al.,2013). Fluoride varnishes have proved a safe method of fluoride application. Advantages of fluoride varnishes over other topical fluoride regimens include protection of enamel in the absence of patient

compliance and continuous fluoride release over a long period of time. The application of a fluoride varnish resulted in a 44.3% decrease in enamel demineralization in patients undergoing orthodontic treatment (Zabokova-Bilbilova , et al.,2014)

(Azarpazhooh and Limeback et al.2008) reported after a 3-year follow -up period that application of a fluoride varnish every 6 months proved most cost-effective technique for high- and medium-risk groups. They also concluded that Durafluor and Duraphat released fluoride at a slow rate for up to 6 months, with the greatest release observed during the first 3 weeks, followed by a more gradual delivery. Therefore, they supported the recommendation of a biannual application of single-dose preparations. However, some studies have recommended an application every 90 days (every 3 months) to promote adequate protection (Vivaldi-Rodrigues , et al.,2006).The application of a fluoride varnish every 6 weeks during orthodontic treatment has been shown to effective in some other studies (Benson , et al.,2013). Recently, an in vivo study by Perrini et al.2016 showed that periodic application of fluoride varnishes in patients undergoing fixed orthodontic treatment can provide some protection against WSLs, which might not be statistically significant if the patients exhibit excellent oral hygiene.

2.3 After the Orthodontic Treatment

After the orthodontic appliances are removed, it is common to see a regression appearance of WSLs due to natural remineralization by saliva and abrasion due to brushing in the presence of oral and food hygiene (Guzmán-Armstrong et al.,2010). This improvement depends on the severity of lesions and occurs in the order of 6 months of the debonding process; however, it is not sufficient and these WSLs should be treated. As a result, Guzmán-

Armstrong et al.2010 recommend a delay of 6 months before treating these lesions.

2.3.1 Remineralization

The first choice for the elimination of WSLs is remineralization which, apart from strict oral hygiene measures, involves repeated applications and the compliance of a motivated patient and might take a long time. Several professionally and home applied products are available in different forms for such a purpose: solutions, varnishes, creams, pastes, and chewing gums. These products contain fluorides and/or casein phosphopeptide-amorphous calcium phosphate, and there is evidence with varying degrees of success in the dental literature (Bishara, et al.,2008;Bergstrand , et al.,2011;Bahoum , et al.,2012).Denis et al.2013 advocated these measures for score of 0 and 1 of these lesions based on the ICDAS classification. However, from the score 2, these measures were unable to remineralize the lesions in all their depth and it was necessary to consider more invasive techniques such as erosion–infiltration (Denis et al.2013), bleaching, and microabrasion (Guzmán-Armstrong et al.,2010).

Products with high concentrations of fluoride are not recommended for the treatment lesions in incisors and canines because they lead to tooth discoloration (Morrier, et al.,2014).

It should be considered that there is a lack of reliable scientific data to support remineralizing or camouflaging approaches to manage postorthodontic WSLs and further well-designed trials are needed (Sonesson, et al.,2016).

2.3.3 Bleaching

The esthetic results of bleaching procedures are limited and they might give rise to tooth sensitivity and a decreased enamel microhardness (Senestraro, et al.,2013). However, a recent study showed that bleaching

incipient enamel caries with 10% carbamide peroxide could camouflage WSLs with no effect on the chemical and mechanical properties of the enamel; in addition, application of casein phosphopeptide-amorphous calcium phosphate was considered an adjunct treatment for promotion of mineral gain in the subsurface lesion (Kim, et al.,2016). Khoroushi et al.2016 showed in an in vitro study that a gentle, noninvasive bleaching procedure by incorporating three different biomaterials, including nano-BAG, nano- hydroxyapatite, and nano-amorphous calcium phosphate, into bleaching agents might mitigate the negative effects of tooth bleaching and prevent the irreversible changes in the enamel surface. This treatment modality should be reserved for patients with good oral hygiene to mask inactive lesions when natural remineralization is not complete (Guzmán-Armstrong et al.,2010).

2.3.4 Microabrasion

Microabrasion consists of a chemical and mechanical processing of the enamel surface by applying an abrasive slurry of 6.6% (Opalustre) or 6% (Whiteness RM) hydrochloric acid with a brush. As microabrasion is relatively more invasive in nature, it was believed that delayed application was beneficial given improvements of lesions through saliva-based remineralization and spontaneous surface abrasion subsequent to debonding (Yetkiner,et al.,2014). This is a useful method for the treatment of postorthodontic WSLs, but the depth of the lesion should be under 0.2 mm (Bishara, et al.,2008; Heymann, et al.,2013) and it might be associated with the bleaching technique (Sundfeld, et al.,2007 Guzmán-Armstrong et al.,2010).

Chapter three: Conclusion and Suggestion

Enamel demineralization around fixed orthodontic appliances is a common complication it might occurs before, during and extend after removal of the appliance .Therefore, careful assessment, discussion of the problem with the patient and educating, motivating him to observe good oral hygiene in the first line of management.

In addition, prophylaxis should be carried out with topical fluoride, antiseptics, micro abrasion, resin infiltration etc… .

Suggestion

further researches are needed to provide effective, fast and less expensive ways for WSL Management.

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