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Research Article

Safety of Posterolateral Approach in High-Risk Patients with Trimalleolar Fractures

Yüksek Risk Faktörlü Trimalleolar Kırık Hastalarında Posterolateral Yaklaşımın Güvenliği

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Abstract

Aim: Purpose of this study is to compare the outcomes of posterolateral approach (PLA) and minimal-invasive percutaneous anteroposterior (AP) approach for the fixation of posterior malleolar fragment in patients who have risk factors for wound healing.

Material and Methods: 66 patients were analyzed in 2 study groups. Group 1: PLA (29 patients), Group 2: AP (37 patients). Patient demographics, risk factors for wound healing, presence of syndesmotic injury, fracture type, postoperative wound-healing complications and American Orthopedic Foot and Ankle Society ankle-hindfoot score (AOFAS) were recorded.

Results: There was no difference between the study groups in regard to wound-healing problems. Obese and smokers had significantly more wound-healing problems regardless of the surgical approach. There was no statistically significant difference between the study groups in regard to AOFAS.

Conclusion: In trimalleolar fractures, PLA can be safely considered even for the patients who have risk factors for wound-healing problems other than obesity and smoking.

Keywords: Posterolateral approach; trimalleolar fracture; high risk patients, smoking, obesity

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Öz

Amaç: Bu çalışmanın amacı, yara iyileşmesi açısından risk faktörleri taşıyan hastalarda posterior malleol fragmanının tespitinde posterolateral yaklaşım (PLY) ve minimal invaziv perkütan anterior-posterior (AP) yaklaşımın sonuçlarını karşılaştırmaktır.

Gereç ve Yöntemler: 66 hasta, 2 çalışma grubunda analiz edildi. Grup 1: PLY (29 hasta), Grup 2: AP (37 hasta). Hasta demografik özellikleri, yara iyileşmesi için risk faktörleri, sindezmotik yaralanma varlığı, kırık tipi, ameliyat sonrası yara iyileşmesi komplikasyonları ve Amerikan Ortopedik Ayak ve Ayak Bileği Derneği ayak bileği-arka ayak skoru (AOFAS) kaydedildi.

Bulgular: Yara iyileşme sorunları açısından çalışma grupları arasında fark yoktu. Obez ve sigara içenlerin, cerrahi yaklaşımdan bağımsız olarak yara iyileşmesi sorunları anlamlı derecede daha fazlaydı. AOFAS açısından çalışma grupları arasında istatistiksel olarak anlamlı bir fark yoktu.

Sonuçlar: Trimalleolar kırıklarda obezite ve sigara kullanımı dışında yara iyileşmesi sorunları açısından risk faktörleri olan hastalarda dahi PLA güvenle düşünülebilir.

Anahtar Kelimeler: Posterolateral yaklaşım; trimalleolar kırık; yüksek riskli hasta, sigara, obezite

Introduction

Posterior malleolar fractures account for 7–44% of all ankle fractures [1–4] and are associated with a high risk of ankle osteoarthritis [3, 5–7]. To prevent this complication, surgeons need to pay particular attention to the reduction of posterior malleolar fragment (PMF) [8].

Traditionally, treatment of PMF can be done by two commonly used methods: reduction followed by percutaneous screws placed in the anteroposterior (AP) direction as a minimally invasive procedure, and direct open reduction using the posterolateral approach (PLA). Although both methods have some advantages and disadvantages discussed in the literature, there are still debates about which surgical method (AP or PLA) should be used.

Recent literature supports PLA because it can give opportunity surgeons for better reduction and clinical results compared to the AP method [9-11]. However, PLA may require expanded approach and is associated with wound complications, especially in trauma patients. PLA also has the potential to sural nerve injury [12]. In contrast, the percutaneous AP approach is a minimally invasive procedure that reduces the risk of wound complications. However, AP approach has the risk of malreduction of the PMF which leads to osteoarthritis in following years.

In the literature, there is broad consensus that when a patient exhibits any factors posing a risk to wound healing, such as significant swelling, smoking, diabetes mellitus, vascular pathologies, etc., surgeons typically favor the percutaneous anteroposterior (AP) approach. Despite acknowledging the potential for malreduction of the articular surface, they are willing to accept this risk. To our knowledge, this study is one of the first studies in the literature to examine the results of the PLA approach alone in patients with risk factors for wound healing. In this study, we hypothesized that, regardless of risks, with careful planning and procedures, PLA can provide the best results of the AP method with comparable wound healing problems.

Therefore, the aim of this study is to assess the clinical results of using both the plate and screw technique and the minimally invasive percutaneous anteroposterior (AP) approach in stabilizing PMF in individuals with trimalleolar fractures and associated risk factors for impaired wound healing.

Materials and Methods

Study Population

After obtaining institutional review board approval (Project Number: KA 20/268), we retrospectively reviewed the pain data of patients who underwent trimalle joint surgery at our hospital between January 2015 and December 2019. Inclusion criteria were: patients undergoing trimalleolar ankle sprain surgery in which PMF was treated by the PL method or a minimally invasive percutaneous AP approach, and patients with lesions causing previously described medical risks (smoking, obesity, diabetes, and peripheral neuropathy) [13]. Exclusion criteria were: (i) bone disease; (ii) tibia (AO-OTA 43 type C); (iii) have joints (inflammatory or degenerative); (iv) exposed bone; (v) cooperation between the parties; (vi) multiple injuries; (vii) patients under 18 years of age; (viii) patients who received no treatment after joint replacement and (ix) patients disappeared 12 months after surgery.

A total of 103 patients were included in this study. Of these 103 patients, 37 were excluded, making a total of 66 patients eligible for the study and final analysis. The collected data were divided into 2 study groups:

Group 1: Patients operated on with the PLA approach (29 patients)

Group 2: Patients operated on with the lateral percutaneous AP approach Patients (37 patients)

Surgical procedures

All surgeries It was performed by 2 orthopedic surgeons. No specific criteria (e.g. size, flexibility) were used to select the type of fixation. The subsequent treatment process of the ankle is determined by the surgeon's preference. All patients are placed in a short leg cast before surgery and are encouraged to rest, ice, and keep pressure low to reduce swelling. Before surgery, patients are evaluated in the hospital; It is examined especially in terms of skin, joints and bones. Patients are only taken into surgery when a plastic surgeon can easily perform it.

A similar surgical procedure is used in all cases. Prepare and seal the lower end of the sterile field as usual. Pneumatic tourniquet was used in all cases.

Lateral approach using percutaneous AP screw position

Using the standard AO (Arbeitsgemeinschaft für Osteosynthesefragen) osteosynthesis procedure, lateral and medial malleolus fractures are fixed with open reduction and internal fixation (ORIF). The patient is sleeping. Anatomical reduction of the lateral and medial malleolus was confirmed under fluoroscopy. The posterior ankle ligament is then reset by the joint and the ankle is dorsiflexed. If necessary, the posterior residual can be reduced anatomically using percutaneous point reducing forceps, bone hooks, Kirschner wires, or periosteal strippers [14, 15]. Intraoperative lateral radiographs were taken using the C-arm to confirm reduction. The entry point of the screw is as medial to the tibialis anterior muscle as possible. The posterior malleolus is then fixed in an anteroposterior direction using one or two 4.0 mm cannulated screws (Figure 1).

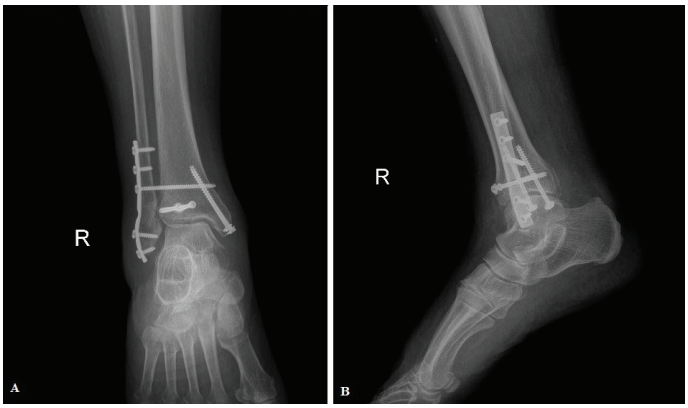

Figure 1: The postoperative anteroposterior and lateral radiograph of a 66-year old male patient treated with posterolateral approach. **A:** Anteroposterior view, **B:** Lateral view.

Posterolateral approach

In this method, before a 10-15 cm longitudinal incision is made between the fibula and the Achilles tendon, the fibula and posterior malleolus are reduced and fixed in the lateral position, and then the patient is placed in a horizontal position. Position to reach the target in medial malleolus fractures. The interval between the peroneus and flexor pollicis longus muscles was used to reveal the PMF. First, the peroneal muscle is pulled medially to stabilize the fibula. The flexor pollicis muscle increases. After direct reduction, fixation is made with a few posteroanterior lag screws or a support plate (3.5 mm. 1/3 tubular plate) placed close to the joint line to stabilize the largest screw. The aponeurotic fascia is closed with 2-0 Vicryl single sutures, and then the skin is closed with interrupted 2-0 polypropylene sutures. Then, a separate incision is made on the medial malleolus and medial malleolus fixation is applied in the supine position (Figure 2).

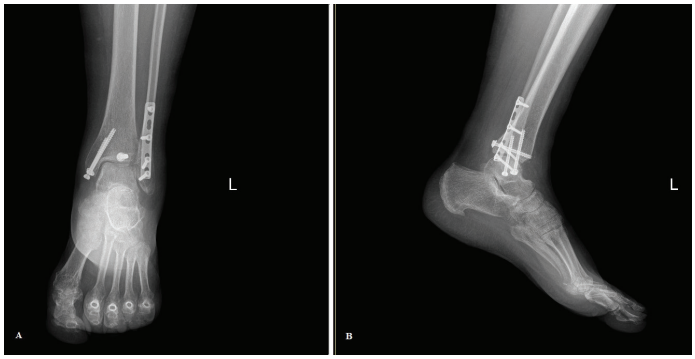

Figure 2: The postoperative anteroposterior and lateral radiograph of a 62-year old male patient treated with lateral approach and percutaneous anteroposterior screw placement. **A:** Anteroposterior view, **B:** Lateral view.

External rotation stress tests and cotton tests were applied to both patient groups during surgery to evaluate the stability and healing of the syndesmosis after fracture. Syndesmotic screws are placed when a positive result is obtained on the external rotation stress test (increased clearance of the ankle joint) or the cotton test (left malleolus displacement > 2 mm) [16, 17].

After the surgery, all bones in the short leg remain motionless for two weeks. Exercise intensity was started 4 weeks after the surgery. Full weight gain is allowed after 3 months. Regular clinical and radiographic evaluations were performed at 2 weeks, 6 weeks, 3 months, 6 months, 12 months, and annually thereafter. Weight-bearing development and strength training began 6 weeks after surgery. Syndesmotic screws, if any, were removed 3 months after the surgery.

Outcome Analysis

Patients related to patients (age, gender, body weight), positive predisposing risk factors for pain (smoking, alcohol, obesity, diabetes and peripheral neuropathy), syndesmotic injury Current data, Fracture types (according to Lauge-

Hansen) were recorded by an independent observer. A risk factor for obesity is a body weight index > 30.

Functional results were finally evaluated according to the American Orthopedic Foot and Ankle Society Ankle Hindfoot Score (AOFAS)[10]. A community or local topic has been closed. Patients with postsurgical pain were specifically identified as: skin wound complications including epidermolysis, eschar formation, and ulceration (Figure 3). Complications in deep wounds include wound thickening and wound dehiscence (Figure 4). Signs of infection (superficial or deep) including erythema and fluid are also recorded as wound pain. Plastic surgeons effectively manage all pain, whether they are plastic surgeons or not. At the end of adaptation, energy measures including conflict, facility failure and regeneration are also taken into account.

Figure 3: Post-operative photo of a 52-year old female patient with trimalleolar fracture treated with lateral approach. Note the skin epidermolysis of the lateral ankle 6 days after surgery.

Figure 4: Post-operative photo of a 61-year old female patient with trimalleolar fracture treated with posterolateral approach. Note the wound dehiscence of the medial malleolar region 10 days after surgery.

Statistical analysis

Statistical analysis was performed using SPSS 22.0 software (SPSS Inc.Chicago, IL, USA). The Kolmogorod-Smirnov test was used to determine whether the data followed a normal distribution. Continuous differences were expressed as mean ± standard deviation (SD), and categorical differences were expressed as range and percentage. Various groups were evaluated with the Kruskal Wallis test based on Lauge-Hansen and Danis-Weber distributions. Mann-Whitney U test was used to analyze AOFAS results between each group. The relationship between all groups and factors was evaluated with the chi-square test. We used logistic regression analysis models to evaluate risk factors associated with wound healing complications and determine the difference. Significant differences using chi-square test and t-test were included in the regression model. Adjusted odds ratio and 95% confidence interval were used to evaluate the effect. For all tests, a p value of < 0.05 was considered significant.

Results

Patients

There were 37 female patients (56.1%) and 29 male patients (43.9%). The average age of the patients was 62.4±5.32 years (range: 49-68) and the average duration was 33.7 months (range: 24-48 months). The demographic characteristics of the study group (age, gender, body weight, and examination) and risk factors for wound healing (smoking, obesity, diabetes, and peripheral neuropathy) and the Lauge Hansen classification of trimalleolar fractures and syndesmotic fractures are summarized in Table 1. There was no significant difference in the demographic characteristics of the study groups, except that the frequency of syndesmotic development was higher in Group 2 (Table 1).

Wound-healing

A total of 29 (29/66, 44%) patients subsequently developed some wound healing problems. Table 2 describes profound (26/66, 40%) and profound (3/66, 4%) pain relief in the study group. There were no significant differences between study groups on various clinical issues. In contrast, analysis of demographic characteristics of the study population, including body weight and risk factors for wound healing, showed that obesity (BMI > 30) and smokers had impaired wound healing regardless of surgery ($p < 0.05$). Additionally, smokers and obese individuals were similar in the groups (Table 1 p: 0.883, p: 0.538). Other factors had no significant effect on wound healing (Table 3).

Table 1: Demographic features of the study group with risk factors and fracture types and statistical comparison results

	Group 1 (%)	Group 2 (%)	P values
Age	64.7	66.3	
Male	14 (48.3)	17 (45.9)	0.811
Female	15 (51.7)	20 (54.1)	0.292
Follow-up (months)	35.2	32.2	0.912
Wound complication	14 (48)	15 (40.5)	0.791
-Lateral incision	11 (37)	12 (32.5)	0.525
-Medial incision	3 (11)	3 (8)	0.2
Risk Factors for Wound-Healing			
-Smoking	18 (62.1)	23 (62.2)	0.883
-Obesity	9 (31.1)	11 (29.7)	0.538
-DM	21 (72.4)	19 (51.3)	0.104
-PN	8 (27.6)	5 (13.5)	0.083
Lauge-Hansen Types			
-Sup-ER	16 (55.2)	22 (59.4)	0.971
-Sup-Adduction	3 (10.3)	2 (5.4)	0.095
-Pron-ExtRot	8 (27.6)	10 (27.1)	0.623
-Pron-Abduction	2 (6.7)	3 (8.1)	0.069
Syndesmotic Injury/ Fixation	23 (79.3)	12 (32.4)	0.012

DM: Diabetes Mellitus, PN: Peripheral neuropathy

Table 2: The wound-healing complications of the study groups and statistical comparison results.

Wound Healing Problems	Group 1 (%)	Group 2 (%)	P values
Superficial			
-Epidermolysis	5 (35.7)	6 (40)	0.662
-Eschar	6 (42.8)	4 (26.6)	0.318
-Ulcer	2 (14.3)	3 (20)	0.511
Deep			
-Necrosis	0 (0)	0 (0)	0
-Dehiscence	1 (7.1)	2 (13.3)	0.678

Table 3: The analysis and statistical comparison results of the study parameters with wound-healing problems.

	Wound-Healing Problem (+)	Wound-Healing Problem (-)	OR (95% Confidence Interval)	P values
Male	12	16	0.6 (0.3-0.9)	0.514
Female	17	21		
Smoking	28	13	2.7 (1.9-2.7)	<0.05
Non-smoking	1	24		
Obesity	14	6	2.1 (1.5-4.2)	<0.05
Non-obesity	15	31		
DM	14	26	0.7 (0.4-2.3)	0.813
Non-DM	15	11		
PN	7	6	1.3 (0.9-5.6)	0.067
Non- PN	21	31		

OR: Odds Ratio, DM: Diabetes Mellitus, PN: Peripheral neuropathy

Follow up

During the follow-up period, only one complication, deep vein thrombosis, occurred in the first group, and the treatment they received will continue. No patient developed peroneal nerve loss, reflex sympathetic dystrophy syndrome, or posterior tibial nerve-related complications. There was only one case that was not included in Group 1 and was treated with bone grafting after 12 months. There was no significant difference between the study groups in terms of electrical problems ($p = 0.612$).

Functional outcome

The average AOFAS scores of the study group at the last follow-up were 88.55 ± 15.24 (range: 82-100) and 83.8 ± 7.4 (range: 78-100). There was no statistically significant difference in AOFAS scores between the two groups ($p = 0.245$).

Discussion

This is one of the first studies in the literature to evaluate the safety of PLA in patients with trimalleolar fractures who are at risk for wound healing. Many studies within the literature focus on surgically treating ankle fractures involving PMF. However, the best choice of PMF approach and treatment method is still a matter of debate. In routine clinical practice, the fixation of PMF typically involves either the utilization of anteroposterior lag screws through an anterior approach or a direct posterior approach, where direct reduction and fixation are achieved using poster anterior screws and/or a posterior buttress plate [18, 19]. PLA has become popular recently with its ability to visualize PMF directly and reduce the fragment with plate and/or lag screws. Although this approach has its advantages, it is not good for patients at risk of wound healing problems and/or neurovascular injuries. Therefore, in this study, we specifically analyze two different surgical approaches for the treatment of trimalleolar fractures in patients who had risk factors for wound-healing and try to understand if PLA is a safe and effective approach even in patients who have predisposing risk factors for wound healing.

Over the past ten years, the literature has commonly acknowledged that PLA serves as a viable substitute for the minimally invasive percutaneous AP screw fixation in addressing (PMF). In a study conducted by Vidović et al., 48 patients were randomly assigned to either direct or indirect fixation of posterior malleolar fractures (PMF). The findings revealed a significantly higher quality of reduction in the directly fixed group, achieving excellent reduction in 79% of cases compared to 45% in the indirect group [11]. Another study by Shi et al.

compared 64 cases with direct fixation to 52 cases with indirect fixation, indicating that the direct reduction technique through a posterolateral approach provides superior fracture reduction quality and functional outcomes in PMF management. This was in contrast to the indirect reduction technique using ligamentotaxis, which resulted in significantly higher functional scores for the direct fixation group [10]. Weigelt et al. reported favorable clinical mid- to long-term results with a high satisfaction rate after a minimum follow-up of 12 months for the direct fixation of posterior malleolar fractures using a plate and screw technique (PLA) [20].

The stability of the syndesmosis is a crucial aspect in trimalleolar fractures, impacting functional outcomes [21]. Existing literature generally supports the notion that achieving anatomical reduction in PMF leads to a more anatomically aligned tibiofibular joint compared to syndesmotic screw fixation, ensuring indirect reduction. Moreover, posterior malleolar fixation has demonstrated greater stability than relying solely on transsyndesmotic screws [16, 18]. Miller et al. conducted an assessment on the incidence of syndesmotic instability after achieving anatomical reduction and stabilization of the posterior malleolus in both supine and prone positions. Their findings indicated a reduced rate of syndesmotic instability in the prone position with direct fixation of the posterior malleolus [22].

Consistent with the literature, our study in Group 1 (PLA group) revealed a significantly lower incidence of ankle fractures requiring syndesmotic fixation. We posit that robust fixation of the PMF contributes to the restoration of the postero-inferior tibiofibular ligament, thereby diminishing the necessity for syndesmotic fixation.

The examination of functional outcomes is a widely explored parameter in the ankle fracture literature. The AOFAS scoring system, recognized for its reliability and validated results, is frequently used for such assessments [23]. In our study, we utilized the same scoring system to evaluate functional outcomes. Numerous studies in the literature consistently indicate that PLA yields superior AOFAS scores compared to the AP approach [10, 12, 24]. While our study did not reveal a statistically significant difference between the groups regarding AOFAS scores, Group 1 (PLA group) exhibited better AOFAS scores than Group 2. This suggests that, for the fixation of PMF, PLA can be safely used across various fracture types, ensuring precise reduction and satisfactory functional outcomes.

Despite the documented advantages of PLA in the literature, it has not superseded the minimally invasive percutaneous AP approach in clinical practice [16]. Studies report that over 80% of cases PMFs are still treated with anterior-to-posterior screws using an indirect reduction technique [25]. Some authors argue that the minimally invasive percutaneous AP approach is less traumatic, citing concerns that PLA may elevate the risk of issues such as posterior scarring, wound healing complications with infection, tendon impingement, and sural nerve injury [26, 27].

The literature commonly identifies patient-related factors associated with an increased risk of wound-healing problems, including diabetes, open fractures, tobacco use, and peripheral neuropathy [13, 28-30]. Additionally, obesity and excessive ankle swelling have been reported as additional risk factors for wound-healing issues [31]. In our current study, we selected smoking, obesity, diabetes mellitus, and peripheral neuropathy as specific risk factors for examining wound-healing problems. Uncontrolled diabetes stands out as one of the most widely recognized predictors of postoperative infection [32]. Smoking, a modifiable risk factor, has been linked to a five-fold increase in the risk of surgical site infection following ankle fracture surgery [33]. Moreover, many orthopedic surgeons contend that obese patients exhibit a higher incidence of perioperative complications and poorer functional outcomes compared to non-obese patients. Notably, we did not assess soft tissue swelling within the study group; all surgical procedures were conducted after the resolution of swelling. In our clinical practice, irrespective of patient factors, we routinely postpone surgery while monitoring preoperative swelling to prevent postoperative wound complications.

The comprehensive rates of complications following surgical intervention for ankle fractures range from 22% to 30% [29, 34]. Little et al. conducted a study analyzing 112 patients with ankle fractures treated using PLA, reporting an overall complication rate of 23% [29]. In a separate investigation, Zaghloul et al. examined 186 patients with rotational ankle fractures, revealing an overall complication rate of 21.5%, with 10.8% categorized as major complications necessitating surgical intervention [35]. Our study yields comparable results, with a total complication rate of 19.7%, and no significant difference observed between the study groups regarding overall complication rates.

The documented incidence of wound-healing problems post-operative treatment for ankle fractures exhibits notable variability in different studies, ranging from 1.4% to 5.5% [30, 36]. Specifically, the skin coverage without enough subcutaneous tissue over the medial and lateral malleoli may make patients more susceptible to postoperative complications, such as superficial infections and skin necrosis [13, 19]. In a study by Zaghloul et al., an analysis of 186 patients

with ankle fractures over the age of 60 concluded that the occurrence of such wound-healing complications could be as high as 18% in elderly patients [35]. More than 50% of these complications, as reported in the literature, are superficial and can be effectively managed by orthopedic surgeons through local wound care. Skin epidermolysis emerges as the most commonly reported complication in these studies. However, approximately 5% of patients require operative intervention for the management of wound complications, and especially skin ulcers are the most common indication. Our study revealed no statistically significant difference between the study groups concerning various types of wound-healing problems. Skin epidermolysis was also the most prevalent problem in our study. There was no significant difference in terms of wound-healing complications between the study groups, indicating that the minimally invasive AP approach did not confer any advantages over the PLA regarding wound healing in trimalleolar fractures.

Limitations

There are several limitations in this study. First, this is a retrospective study with a limited number of cases. Future studies are needed with larger study groups and longer follow-up time. Second, the radiographic osteoarthritis status was not graded or compared between groups due to limited time of follow-up. Third, no stratification of age groups was made and no data were available comparing different age groups and finally, all parameters of wound-healing were not evaluated in the current study.

Conclusion

In conclusion, the direct reduction of the PMF through PLA is a safe procedure without an increased rate of wound-healing complications for the treatment of trimalleolar ankle fractures. For the surgical treatment of these fractures, the physician should be more alert in obese and/or smoking patients regardless of the surgical approach. In trimalleolar fractures, if the surgeon decides to fix the PMF, then PLA may be the choice for a direct reduction even for the patients who have risk factors for wound-healing problems other than obesity and/or smoking. In order to understand the best effective approach (PLA vs. Percutaneous AP) for trimalleolar fractures, future randomized comparative studies are needed in the literature.

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