

# Prognostic role of preoperative D-dimer, fibrinogen and platelet levels in patients with oral squamous cell carcinoma

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## Research article

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# Abstract

**Background:** The relationship between cancer and coagulation has been intensively studied in recent years; however, the effects of coagulation factors on oral squamous cell carcinoma (OSCC) have rarely been reported. This study aimed to investigate the relationship between preoperative D-dimer (DD), fibrinogen (FIB), platelets (PLT) and OSCC, as well as the prognostic value of DD, FIB and PLT in OSCC.

**Methods:** We retrospectively investigated a total of 202 patients with OSCC treated at Guanghua Hospital of Stomatology, Sun Yat-sen University. Baseline demographic and clinicopathological information as well as both preoperative and postoperative DD, FIB and PLT results were collected from each patient, and all patients were followed up for disease progression, death or the end of the study. The correlations between preoperative DD, FIB, PLT and other clinical features, as well as the therapeutic effect and PFS were analysed statistically, and postoperative DD and surgical parameters were also analysed.

**Results:** Preoperative DD was significantly correlated with T stage, N stage, clinical stage and relapse of OSCC ( $P=0.000$ ,  $0.001$ ,  $0.000$  and  $0.000$ , respectively). Univariate and multivariate Cox regression analyses showed that high preoperative DD independently predicted poor prognosis in patients with OSCC ( $r=2.1$ ,  $P=0.033$ ), while FIB and PLT showed no prognostic values. Postoperative DD was significantly correlated with preoperative DD and surgical type but not the duration of surgery ( $P=0.005$ ,  $0.001$  and  $0.244$ , respectively).

**Conclusion:** In this study, we suggested that high preoperative DD level may serve as an indicator for synchronous neck dissection in patients with T<sub>1,2</sub> OSCC, and the elevated DD level might be the marker of disease progression in patient follow up.

## Background

Oral squamous cell carcinoma (OSCC) is one of the most commonly seen malignancies in the head and neck region, and tumour cell proliferation and metastasis occur at high rates even at the very first stage of the primary tumour. Approximately one-half of patients are already in advanced stages of disease when diagnosed (1). Despite remarkable advances in diagnostic techniques and therapeutic methods, the long-term survival rates of oral squamous cell carcinoma remain poor.

The correlation between cancer and hypercoagulation has been noticed since the 19<sup>th</sup> century, as global haemostasis is more frequently activated in patients with cancer, and much attention has been devoted to this research field. D-Dimer (DD) is a degradation product of the cross-linked fibrin polymer that is sensitive to both coagulation and fibrinolysis activation (2). Fibrinogen (FIB) and platelets (PLT) can also partly reveal the coagulation state of the patient. Previous studies have reported that pre-treatment plasma DD, FIB and PLT levels can predict prognosis in several types of malignancies, including ovarian (3), breast (4, 5), lung (6,7), colorectal (8), gastric (9), and pancreatic cancers (10). However, few studies have reported the use of preoperative DD levels to predict the prognosis of oral cancer. To the best of our

knowledge, this is the first study to address the prognostic significance of perioperative DD, FIB and PLT levels and their relationship with clinicopathologic parameters in patients with OSCC.

## Methods

### Patient characteristics

We collected a total of 202 cases in this retrospective study, including 148 males and 54 females, with a mean age of 56.3 (median 56, range 25-89) years old. Of the 202 patients, 155 had primary OSCC in our department, and the remaining 47 had recurrent lesions after surgical treatment in other medical institutions. The mean follow-up period was 13.62 (median 10, range 1 to 56) months. The clinical parameters of all 202 patients are shown in Table 1.

### Relationship between preoperative plasma DD, FIB, and PLT levels and clinicopathologic parameters

Of the 202 patients, preoperative FIB and PLT levels were closely related to each other ( $r=0.376$ ,  $P=0.000$ ); however, the preoperative DD level and preoperative FIB and PLT levels were not significantly related ( $P=0.053$  and  $0.636$ , respectively).

Preoperative plasma DD, FIB, and PLT levels and clinicopathologic parameters, including age, sex, tumour location, TNM staging, surgical treatment and duration, are summarized in Table 2. The mean preoperative DD level was 499.45  $\mu\text{g/L}$ , and referring to the manufacturer's recommendation, a plasma DD level of 500  $\mu\text{g/L}$  was set as the cut-off value for normal and high DD values. The mean preoperative FIB and PLT levels were 3.33 g/L and  $259.5 \times 10^9/\text{L}$ , respectively, and were set as cut-off values for low and high FIB and PLT values, respectively. In this study, we found that the preoperative DD level in different sex or age groups of patients was not statistically different ( $P=0.187$  and  $0.062$ , respectively); however, in different tumour sites and in different T stage, N stage, and clinical stage patients, the preoperative DD level was significantly different ( $P=0.040$ ,  $0.000$ ,  $0.001$  and  $0.000$ , respectively). However, with regard to preoperative FIB and PLT levels, we found different results: the preoperative FIB level was different based on sex and N stage category only ( $P=0.025$  and  $0.002$ , respectively), and the preoperative PLT level was different based on tumour site and clinical stage category only ( $P=0.048$  and  $0.040$ , respectively).

The means of DD, FIB and PLT in patients with primary oral cancer were 424.96  $\mu\text{g/L}$ , 3.49 g/L and  $249.11 \times 10^9/\text{L}$ , respectively, and those in patients with recurrent tumours were 752.07  $\mu\text{g/L}$ , 3.82 g/L and  $283.72 \times 10^9/\text{L}$ , respectively. The difference in DD and FIB levels between primary and recurrent cancer was statistically significant ( $P=0.018$  and  $0.038$ , respectively) (Figure 1).

### Relationship between postoperative DD change and treatment-related parameters

We retrospectively observed postoperative DD levels in the first 3 days after surgery and in 96 patients with postoperative DD results. The postoperative DD level was elevated in all 96 patients on the first day after surgery and slowly decreased with time. The elevated level was correlated with the preoperative DD

level ( $r=0.284$ ,  $P=0.005$ ) as well as the surgical type ( $r=0.344$ ,  $P=0.001$ ) but not the duration of surgery ( $P=0.244$ ) (Table 3).

### **Survival analysis of patients with primary OSCC**

According to the NCCN guidelines and patient desire, 155 patients with primary OSCC were prescribed to different surgical plans including 1) excision of the primary lesion (19.4%); 2) excision of the primary lesion and neck dissection (25%); 3) excision of the primary lesion and vascularized free flap transplantation (0.9%); 4) excision of the primary lesion, neck dissection and vascularized free flap transplantation (51.9%); and 5) unoperated (2.8%). Of the 155 patients with primary oral cancer, recurrence was diagnosed in 33 patients after surgical treatment in our department, rated 21.29%, and 26 of them died during the follow-up time. The time from surgery to disease progression ranged from 1 to 34 months. Univariate analyses revealed that N stage ( $P=0.003$ ) and preoperative DD level ( $P=0.033$ ) were predictors of PFS. In multivariate analysis, we demonstrated that the pre-surgery plasma DD level was an independent prognostic factor in patients with primary OSCC ( $P=0.042$ ) (Table 4, Figure 2).

In our study, PFS was 78.7%. Patients with normal preoperative DD ( $<500 \mu\text{g/L}$ ) had a significantly better PFS than patients with high preoperative DD ( $\geq 500 \mu\text{g/L}$ ) (81.7% vs. 74.2%,  $P=0.027$ ).

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## **Results**

### **Patient characteristics**

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The data that support the findings of this study are available from the corresponding author upon reasonable request.

## **Discussion**

In this study, we evaluated the relationship between preoperative DD, FIB, and PLT levels and the clinicopathological characteristics of OSCC, as well as the prognostic effect of preoperative DD, FIB and PLT. To the best of our knowledge, this is the first study to address this issue. We found that preoperative DD was significantly different in patients with OSCC with different primary sites or clinical stages, and DD could serve as an independent prognostic factor for patients with OSCC.

However, preoperative FIB and PLT did not show such strong predictive effects. Previous studies have reported that preoperative DD, FIB and PLT have certain prognostic value in several types of cancer (11), including small cell lung cancer (7), hepatocellular carcinoma (6), pancreatic adenocarcinoma (10), gastric cancer (12), and melanoma (13). PLT was found to contribute to cancer progression through both thrombin-dependent and thrombin-independent mechanisms (14). FIB is important in blood clotting, fibrinolysis and cellular and matrix interactions (15). Zheng S et al. found that FIB can enhance PLT adhesion to tumour cells, and PLT in turn can release thrombin and facilitate FIB aggregation (16). However, unlike most studies of DD, which set the cut-off value to 500 ng/L, there were no consistent cut-off values of FIB and PLT in most of the studies. Hou C et al. (7) set the cut-off values of FIB and PLT as 2.75 g/L and  $215 \times 10^9/L$ , respectively, and they found a marginally significant relationship between elevated PLT and unfavourable PFS ( $P=0.05$ ) and no prognostic role for FIB. Liu Z and Liu P (6,10) used 4.0 g/L as the cut-off value for FIB and  $300 \times 10^9/L$  for PLT, and both were significantly correlated with overall survival ( $P<0.001$  and  $P=0.010$ , respectively). In a study by Holzinger et al. (17), 447 mg/dL was set as the cut-off value for FIB in patients with oral and oropharyngeal cancer, and elevated FIB was associated with poor overall survival ( $p=0.005$ ) and recurrence-free survival ( $p=0.008$ ). In our study, the cut-off values of FIB and PLT were set as the mean value (3.33 g/L and  $259.5 \times 10^9/L$ , respectively). We did find that the FIB level was significantly different between primary and recurrent OSCC, and yet in the survival analysis for primary OSCC, no significant predictive value for PFS was found. We supposed that the inconsistent result between our study and previous studies might be tumour type specific or can partly be attributed to the different sensitivities and different cut-off values of FIB and PLT in different articles.

Cervical lymph node metastasis is the main prognostic factor for patients with OSCC, and neck dissection is an important and effective treatment. However, the complications of neck dissection are severe and significantly lower patients' quality of life. For  $cT_{1,2}N_0$  OSCC patients, even in the NCCN guidelines, there are no definite instructions about performing neck dissection. In this study, the preoperative DD level was found to be significantly correlated with N stage and could serve as an independent prognostic factor for patients with OSCC. Thus, we suggest that a high preoperative DD level may serve as an indicator for synchronous neck dissection in patients with  $T_{1,2}$  OSCC.

It is well known that surgical trauma is associated with coagulation, and Friedrich found that DD increased at the end of surgery and remained increased 24 hours after surgery (18). To further reveal the trauma caused by surgical treatment in patients with OSCC, we evaluated the postoperative DD levels and found that postoperative DD was markedly elevated within 24 hours and then decreased slowly with time if there were no adverse effects, such as local or general infection or venous thrombosis. Moreover,

the rising DD significantly correlated with surgical type but not the duration of surgery. In particular, patients who underwent the most extensive surgery had the highest elevation of postoperative DD level, suggesting that surgical trauma is correlated with the extent of surgery but not the duration of surgery. A relationship between elevated DD and local or general infection and deep vein thrombosis (DVT) was not found in our study, as limited cases developed infection (6/202) and DVT (1/202) after surgery. We also investigated the postoperative DD level with PFS and found that it did not predict PFS.

## Conclusions

DD is an easily measured and reproducible molecular marker. Plasma DD can be routinely measured prior to operations in various hospitals. In this study, we found that high preoperative DD level was significantly correlated with the more advance T and N stage, relapse cases as well as poor PFS in patients with OSCC. We suggest that a high preoperative DD level may serve as an indicator for synchronous neck dissection in patients with T<sub>1,2</sub> OSCC and that continuous DD monitoring can be used in OSCC patient follow-up. Certainly, prospective studies and further studies with larger sample sizes are needed to confirm these findings. In addition, postoperative DD can partly reflect surgical trauma and postoperative adverse effects such as infection or venous thrombosis. Therefore, we suggest that preoperative and postoperative DD can be obtained as part of routine care for patients with OSCC.

## List Of Abbreviations

DD	D-Dimer
FIB	Fibrinogen
PLT	Platelets
OSCC	Oral squamous cell carcinoma
PFS	Progression-free survival
UICC	Union for International Cancer Control
NCCN	National Comprehensive Cancer Network

## Declarations

### Ethics approval and consent to participate

This study was approved by the Ethics Committee of Guanghua Hospital of Stomatology, Sun Yat-sen University. Written informed consent was obtained from all participants included in the study, with the approval number signed as 2011-02.

### Consent for publication

Not applicable.

## Availability of data and materials

The dataset supporting the conclusions of this article is included within the article and its additional file.

## Competing interests

The authors declare that they have no competing interests.

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This study is supported by a grant from the 5010 Clinical Medical Research Project of Sun Yat-sen University, grant number: 2010018. The funder had no role in the design of the study; collection, analysis, interpretation of the data; or writing of the manuscript.

## Authors' contributions

YL, XL and GL conceived and designed the experiments. YL and XM contributed to the acquisition of data and performed the experiments. SZ contributed to patient follow-up. BZ and LY analysed and interpreted the data. YL wrote the paper. XL and GL revised the manuscript and gave final approval of the version to be published. All authors read and approved the final manuscript.

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## Tables

Table 1 Demographic and clinical characteristics of the patients.

Clinical characteristic	Category	N(%)
Sex	Male	148(73.3)
	Female	54(26.7)
Age(years)	<60	130(64.4)
	≥61	72(35.6)
Tumor site	Tongue	93 (46.0)
	Buccal mucosa	33 (16.3)
	Gingiva	40 (19.8)
	Floor of mouth	18 (8.9)
	Palate	8 (4.0)
	Lip	4 (2.0)
	Lymph node in the neck	6 (3.0)
T stage	T1(primary)	29(14.36)
	T2(primary)	53(26.24)
	T3(primary)	26(12.87)
	T4(primary)	47(23.27)
	Relapse & metastasis	47(23.27)
N stage	N0(primary+relapse)	95+28(60.89)
	N+(primary+relapse)	60+19(39.11)
Clinical stage	I	25(12.38)
	II	40(19.80)
	III	25(12.38)
	IV	65(32.18)
	Relapse	47(23.27)
Primary or relapse	Primary	155(76.73)
	Relapse	47(23.27)
Preoperative D-dimer (µg/L)	Median	358.47
	First and third quality	184.36, 581.74
Preoperative FIB (g/L)	Median	3.56
	First and third quality	2.88, 4.08
Preoperative PLT (10 <sup>9</sup> /L)	Median	246.5
	First and third quality	210.00, 305.00

Table 2 Correlation between plasma DD, FIB, PLT levels and patient/tumor characteristics in OSCC cases.

Variables	Preoperative DD ( $\mu\text{g/L}$ )			Preoperative FIB (g/L)			Preoperative PLT ( $10^9/\text{L}$ )		
	$\leq 500$	$\geq 500$	<i>P</i>	$\leq 3.33$	$\geq 3.33$	<i>P</i>	$\leq 259.5$	$\geq 259.5$	<i>P</i>
Sex			0.187			0.025			0.114
Male	105	43		51	97		78	63	
Female	34	20		28	26		40	21	
Age			0.062			0.070			0.415
$\leq 60$	92	33		55	70		70	53	
$\geq 60$	47	30		24	53		47	32	
Tumor site			0.040			0.387			0.048
Tongue	74	19		42	51		58	28	
Buccal mucosa	18	15		12	21		18	11	
Gingiva	23	17		13	27		22	25	
Floor of mouth	14	4		8	10		11	9	
Palate	4	4		1	7		1	7	
Lip	2	2		2	2		1	1	
Neck (LN)	4	2		1	5		6	4	
T stage			0.000			0.129			0.194
T1(primary)	26	3		14	15		15	9	
T2(primary)	39	14		21	32		36	16	
T3(primary)	23	3		11	15		14	7	
T4(primary)	30	17		22	25		30	28	
Relapse	21	26		11	36		23	24	
N stage			0.001			0.002			0.167
N0(Primary)	75	20		34	61		56	28	
N+(Primary)	43	17		34	26		39	32	
N0+Relapse	12	16		9	19		15	13	
N+Relapse	9	10		2	17		8	11	
Clinical stage			0.000			0.094			0.040
I	22	3		11	14		14	3	
II	30	10		15	25		27	10	
III	21	4		10	15		13	12	
IV	45	20		32	33		41	35	
Relapse	21	26		11	36		23	24	
Primary/Relapse			0.000			0.012			0.113
Primary	118	37		68	87		96	59	
Relapse	21	26		11	36		23	24	

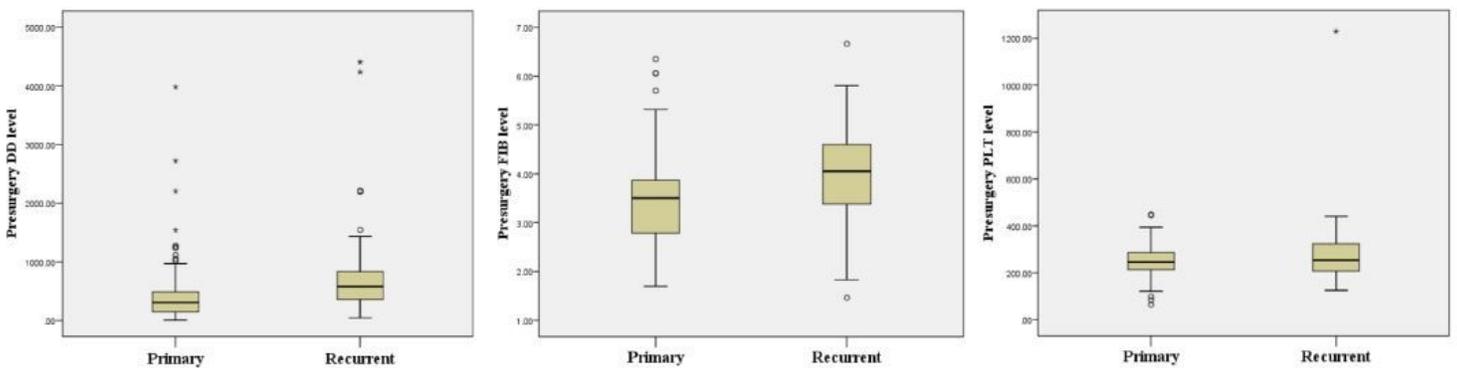
Table 3 Correlation between postoperative DD change and treatment related characters.

	Preoperative DD		Surgery type		Time consuming of surgery	
	<i>r</i>	<i>P</i>	<i>r</i>	<i>P</i>	<i>r</i>	<i>P</i>
Postoperative DD	0.284	0.005	0.344	0.001	0.132	0.244

Table 4 Univariate and multivariate analysis for disease-free survival of patients with primary OSCC.

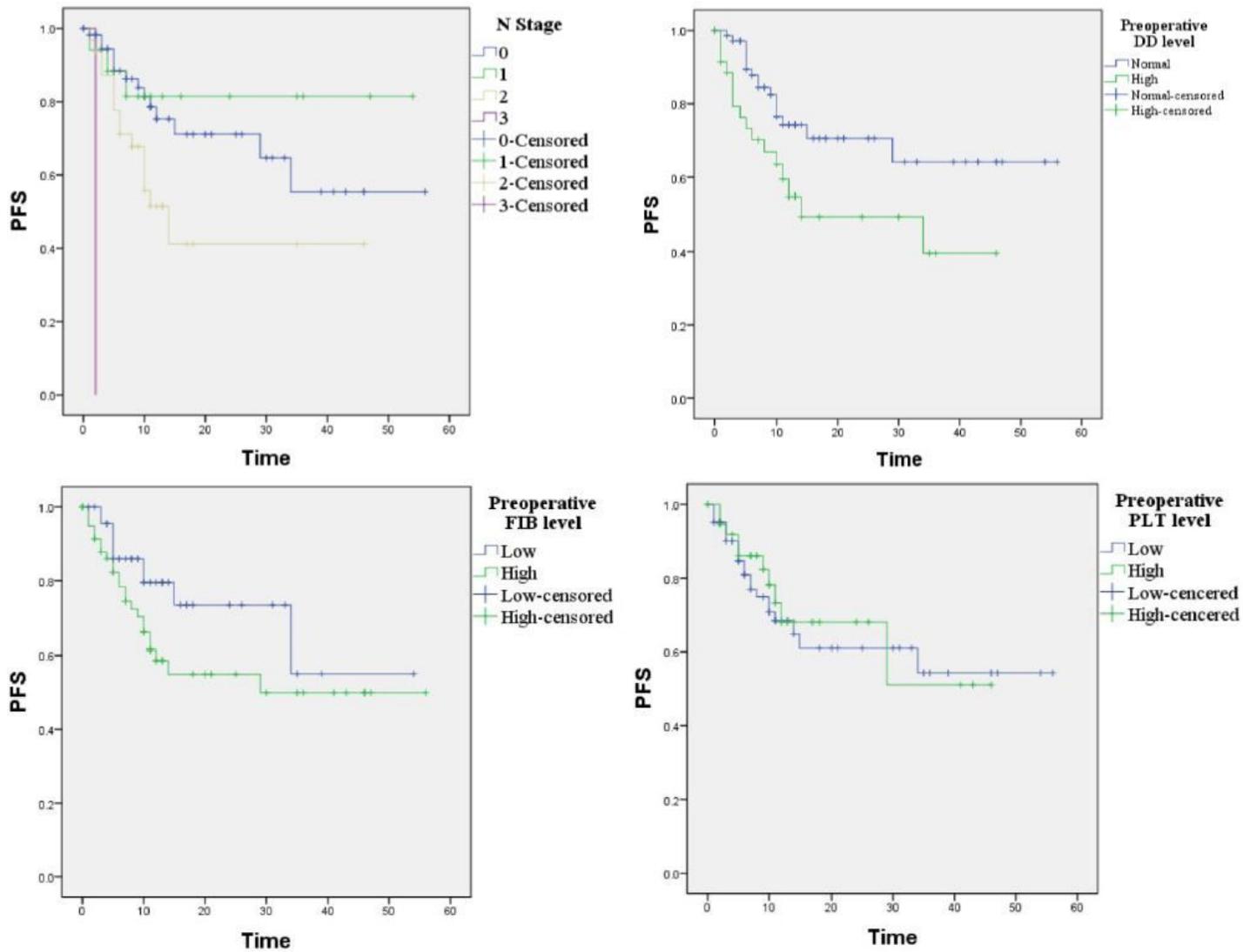
Variables	Univariate analysis		Multivariate analysis	
	HR (95% CI)	P	HR (95% CI)	P
Sex		0.466		
Male	1.00			
Female	0.73(0.32-1.69)			
Age(years)		0.834		
<60	1.00			
≥60	1.08(0.52-2.23)			
T stage		0.884		
T1~T2	1.00			
T3~T4	1.05(0.53-2.08)			
N stage		0.003		0.007
N0	1.00		1.00	
N1	0.68(0.20-2.38)	0.548	0.723(0.21-2.55)	0.619
N2	2.20(1.05-4.57)	0.036	2.46(1.16-5.23)	0.019
N3	33.94(3.65-315.9)	0.002	19.34(2.00-186.96)	0.010
Clinical stage		0.499		
I~II	1.00			
III~IV	1.29(0.62-2.72)			
Pre. D-dimer		0.033		0.040
<500μg/L	1.00		1.00	
≥500μg/L	2.10(1.06-4.16)		1.98(0.98-3.97)	
Pre. FIB		0.097		0.100
<3.33g/L	1.00		1.00	
≥3.33g/L	1.88(0.89-3.95)		1.94(0.88-4.26)	
Pre. PLT		0.699		
<259.5*10 <sup>9</sup> /L	1.00			
≥259.5*10 <sup>9</sup> /L	0.86(0.40-1.84)			
Surgical type		0.732		
1	1.00			
2	1.40(0.57-3.44)	0.461		
3	1.53(0.70-3.34)	0.284		
4	0.00(0.00-)	0.983		
Post.DD change		0.791		
<1000μg/L	1.00			
≥1000μg/L	1.16(0.39-3.46)			
Post. PLT change		0.622		
<60*10 <sup>9</sup> /L	1.00			
≥60*10 <sup>9</sup> /L	1.22(0.55-2.74)			

## Figures



**Figure 1**

The difference of DD, FIB and PLT levels between primary and recurrent OSCC. P=0.018, 0.038 and 0.062, respectively.



**Figure 2**

Survival analysis of primary OSCC patients.  $P=0.003 \times 0.033 \times 0.097$  and  $0.699$ , respectively.