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Original Research

The Influence of Major Depressive Disorder at Both the Preoperative and Postoperative Evaluations for Total Knee Arthroplasty Outcomes

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Abstract

Objective. The purpose of this paper is to analyze the impact of major depressive disorder, both preoperatively and one year postoperatively, on the functional and psychosocial outcomes of total knee arthroplasty (TKA). **Methods**. Two hundred sixty patients undergoing a total knee arthroplasty completed both the baseline and 12-month follow-up assessments. Short-Form Health Inventory (SF36), Western Ontario and McMaster University Arthritis Index (WOMAC), and Knee Society Score (KSS) were measured both preoperatively and postoperatively. The Patient Health Questionnaire (PHQ) was used to diagnose major depressive disorder (MDD) at baseline and follow-up; patients were then classified into one of four groups: No MDD, Lost MDD, Gained MDD, and Continuous MDD. Univariate analysis compared the four groups at baseline, one-year follow-up, and change scores using a Kruskal-Wallis test for continuous data or a chi-square test of independence for categorical data. **Results**. Two hundred seven (79.60%) patients were in the No MDD group, 22 (8.50%) patients were in the Lost MDD group, 19 (7.30%) patients were in the Gained MDD group, and 12 (4.60%) patients were in the Continuous MDD group. There were significant between-group differences present in baseline measures of WOMAC and SF36 mental health summary. In addition, there were significant group differences in the follow-up WOMAC, KSS, and SF36 scores. **Conclusions**. Depression was associated with poorer preoperative and postoperative TKA scores. Patients who were depressed 12 months after surgery demonstrated poorer recovery than patients who did not show depressive symptoms before TKA or within the year after.

Key words: Depression; Orthopaedic Surgery; Physical Function; Quality of Life; Postoperative Outcomes

Introduction

Total knee arthroplasty (TKA) is a widely used surgical method that helps reduce pain and restore knee function in patients with severe osteoarthritis. Most patients report decreases in pain and improved function following TKA. However, recovery is not equal across all patients; therefore, it is appropriate to identify characteristics of patients that are associated with poor surgical recovery outcomes.

There are several patient factors shown to be associated with poor postoperative outcomes following TKA, including increased postoperative pain, reduced function, and decreased quality of life. Patients who are older [1,2], have lower incomes [3], have a greater body mass index [1,2,4,5], are prone to more allergies [6], have past knee surgeries [4], have less preoperative patient activation [7], are female [3,4,8], and have a medical comorbid disease such as diabetes [1,4,9], pulmonary disease [4,10], renal disease [10], and heart disease [11] tend to experience poorer TKA outcomes. Risk factors for requiring a revision TKA surgery include drug abuse, alcohol abuse, increased body mass index, chronic pulmonary disease, and renal disease [10,12]. Age, gender, obesity, and diabetes are also associated with an increased risk of postoperative complications and a higher risk of mortality following the TKA surgery [1,10,13].

Importantly, the addition of other medical diseases increases disease burden by adding to hospital costs and length of stay [14]. Given the expense of extended hospital stays, unexpected readmission, and revision surgeries [14,15], it is beneficial to select patients with the greatest potential for a successful surgery.

In recent years, depression has been identified as an important patient factor in predicting TKA outcomes. Similar to other comorbid disease, higher levels of depression are associated with longer lengths of hospital stay and higher costs of medical treatment, rehabilitation, and outpatient care [16–18]. In addition, preoperative depression is correlated with patient dissatisfaction [19], higher pain scores and poorer function scores [4,8,11,20–26], and risk of revision after the TKA surgery [10]. More depressed patients exhibit poorer pain and function scores both preoperatively and postoperatively [21,26]; however, similar net changes postoperatively are experienced by the patients with depression and patients without depression. This suggests that TKA could still be a beneficial surgery for depressed patients.

TKA research is mixed on the relationship between depression and knee pain and functioning. For example, some research has suggested that depression manifests due to pain and disability from the knee [20]; thus, the depression improves as the knee heals postsurgery. In contrast, another study found no association between depression and preoperative knee pain [27]. Given the mixed research on the relationship between depression and knee pain and functional outcomes following TKA, the purpose of the current study was to analyze the impact of major depressive disorder, both preoperatively and one year postoperatively, on functional and psychosocial outcomes of TKA.

Methods

Participants and Procedures

As a prospective study evaluating physical and psychosocial outcomes following TKA between the years 2006 and 2010, 412 patients volunteered to be part of the study and completed baseline instruments before TKA. At the one-year follow-up, 299 patients returned for the evaluation to complete the follow-up instruments. Of those patients, 260 had valid preoperative and postoperative data for the depression assessment and were included in the analyses for this study. All patients consented verbally and in writing, and this study was approved by the Institutional Review Board at the University of Texas–Southwestern Medical School. Exclusion criteria for this study included age younger than 18 years, prior TKA, cognitive impairments, and the inability to speak or read English or Spanish.

All patients entered in the study underwent standard total knee arthroplasty, and all procedures were performed by the same senior surgeon. On the first day following surgery, all patients began physical therapy, which continued at either an inpatient clinic, an outpatient clinic, or at home.

Of the sample of 260 patients who completed both initial and 12-month follow-up psychological assessment, 207 (79.60%) patients did not have major depressive disorder (MDD) at either assessment, and 12 (4.60%) patients had MDD at both assessments (i.e., continuous). Throughout the course of the study, 22 (8.50%) patients who initially had MDD no longer had MDD (i.e., lost), and 19 (7.30%) patients who did not initially have MDD developed MDD (i.e., gained). Based on both the initial and 12-month follow-up psychological assessments, patients were categorized into four groups: No MDD, Lost MDD, Gained MDD, and Continuous MDD.

Materials

For both the baseline and one-year postoperative assessments, questionnaires, available in both English and Spanish, were administered to assess demographic, physical, and psychosocial variables. The demographic factors assessed included age, gender, race/ethnicity, education level, and insurance coverage.

The Patient Health Questionnaire (PHQ) was utilized to assess the presence of major depressive disorder. This instrument is a self-report measure that has been validated against the Structured Clinical Interview for DSM-IV Axis I mental health disorders [28].

The Short-Form Health Inventory (SF-36) was used as a comprehensive quality of life instrument providing a composite score for both physical health (PCS) and for mental health (MCS). The scores on the SF-36 range from 0 to 100, with higher scores indicating better overall quality of life. The scores are standardized such that the mean is 50, with a standard deviation of 10 [29].

Pain, stiffness, and physical functioning were assessed with both the Western Ontario and McMaster University Arthritis Index (WOMAC) [30,31] and the Knee Society Score (KSS) [32]. The WOMAC is a self-report instrument for end-stage lower extremity osteoarthritis evaluating pain, stiffness, and function. Higher scores on the WOMAC indicate greater levels of pain and stiffness and reduced function. The KSS provides both a subjective and an objective assessment of pain, function, and range of motion of the knee. Lower scores on the KSS indicate more pain, less function, and lower range of motion.

Statistical Analysis

The patients were placed into four comparison groups based on the presence of major depressive disorder at baseline and follow-up. Univariate analysis compared the four groups at baseline, one-year follow-up, and change scores using a Kruskal-Wallis test for continuous data or a chi-square test of independence for categorical data. Post hoc pairwise comparisons were used to identify significant group differences following the omnibus

Table 1. Demographic variables

Variables	No MDD N = 205	Lost MDD N = 22	Gained MDD N = 19	Continuous MDD N = 12	Statistical Comparison, *P* Value
Age, mean (SD), y	62.71 (8.88)	58.64 (7.97)	59.47 (5.96)	54.42 (6.93)*	0.002
BMI, mean (SD), kg/m^2	32.71 (6.94)	33.24 (5.90)	34.65 (6.18)	33.84 (6.55)	NS
Male gender, %	31.10	31.80	31.60	33.30	NS
Race/ethnicity, %					
African American	25.60	36.40	31.60	50.00	NS
Caucasian	31.90	13.60	42.10	25.00	
Hispanic/Latino	36.70	45.50	21.10	16.70	
Other	5.80	4.50	5.30	8.30	
Education level, %					
No high school	32.80	47.60	23.50	27.30	NS
High school	42.50	33.30	35.30	45.50	
College	17.70	19.00	35.30	27.30	
Postgraduate	7.00	0.00	5.90	0.00	
Income level, %					
<10,000	58.50	72.70	63.20	75.00	NS
10,000–25,000	20.80	18.20	31.60	25.00	
25,000–40,000	4.80	4.50	0.00	0.00	
40,000–60,000	2.90	0.00	0.00	0.00	
60,000–100,000	7.70	0.00	0.00	0.00	
100,000+	2.90	0.00	5.30	0.00	
Insurance, %					
Government	35.70	22.70	36.80	33.30	NS
Commercial	14.00	9.10	5.30	0.00	
Other	40.10	50.00	36.80	25.00	
None	10.10	18.20	21.10	41.70	

BMI = body mass index; MDD = major depressive disorder.

*Denotes a significant post hoc difference from the No MDD group.

Kruskal-Wallis test. Bonferroni correction for multiple comparisons was applied for all post hoc tests. A binary logistic regression model was developed to determine the key one-year factors associated with major depressive disorder at the one-year time point. Predictors of MDD status included age, gender, race/ethnicity, the SF-36 mental and physical health composite scores, and the KSS pain and function scores. The significance level was set at $P = 0.05$. A post hoc power analysis was conducted using a one-way omnibus analysis of variance, with a medium effect size ($f = 0.25$, $N = 260$, $P < 0.05$) and calculated power of $(1\text{-}ß) = 0.93$. All analyses were conducted using SPSS, v. 24.0 (IBM Corp, Armonk, NY, USA).

Results

Table 1 presents the demographic makeup for each of the four groups. The four groups were compared using a Kruskal-Wallis test for continuous data or a chi-square test of independence for categorical data. There were no significant differences in gender, body mass index, ethnicity, income level, education levels, and insurance type between the four groups. However, there were group differences in age ($H(3) = 14.671$, $P = .002$). A post hoc pairwise comparison test found that the Continuous MDD ($M = 54.42$) group had a significantly lower age than the No MDD group ($M = 62.71$).

Table 2 provides the four groups' SF36 mental and physical health composite scores at initial assessment and 12-month follow-up. In addition, the overall change scores from initial assessment and 12-month follow-up are provided. At the initial assessment, there were only group differences present for the MCS showing that those in the No MDD group had the highest quality of life scores. However, at the 12-month follow-up, both the MCS and PCS had significant group differences. Specifically, the Continuous MDD group had a much lower quality of life postsurgery than the other groups. Despite these differences, there were no significant change scores, indicating that each group had similar improvements in scores from the initial assessment.

Table 3 provides the four groups' WOMAC physical functioning initial, 12-month follow-up, and change scores. The scores for the WOMAC can be divided into four different measures: pain, stiffness, function, and total. With the exception of the change score for stiffness, the groups significantly differed on all WOMAC initial, 12-month follow-up, and change scores. Overall, both the No MDD and Lost MDD groups demonstrated greater postoperative physical functioning than the Gained MDD and Continuous MDD groups. Figure 1 shows the preoperative and postoperative WOMAC total scores for the four groups.

The Knee Society assessment initial, 12-month follow-up, and change scores for each group can be seen in Table 4. The Knee Society assessment provides a measure of pain, stability, and range of motion. At initial

Table 2. SF-36 quality of life comparisons

SF-36 Mean (SD)	No MDD N = 202	Lost MDD N = 21	Gained MDD N = 18	Continuous MDD N = 12	Statistical Comparison, *P* Value
Physical health summary					
Baseline	30.47 (9.38)	28.94 (7.30)	32.06 (8.44)	28.84 (6.82)	NS
One year postop	41.60 (11.52)	40.15 (11.35)	37.39 (9.94)	33.46 (8.17)	0.048
Change score	11.15 (13.75)	13.85 (12.50)	4.50 (10.21)	4.63 (5.23)	NS
Mental health summary					
Baseline	51.62 (11.85)	39.31 (8.93)*	39.76 (8.03)*	27.36 (7.69)*	<0.001
One year postop	52.53 (10.18)	46.61 (13.43)	40.10 (9.38)*	30.64 (14.14)*	<0.001
Change score	1.28 (12.31)	8.03 (16.08)	−3.46 (11.61)	3.28 (12.22)	NS

MDD = major depressive disorder.
*Denotes a significant post hoc difference from the No MDD group.

Table 3. WOMAC comparisons

WOMAC Initial Assessment Mean (SD)	No MDD N = 201	Lost MDD N = 22	Gained MDD N = 18	Continuous MDD N = 12	Statistical Comparison, *P* Value
WOMAC – pain					
Baseline	11.78 (4.36)	13.82 (4.72)	13.22 (4.42)	15.08 (3.40)	0.010
One year postop	4.94 (7.13)	6.71 (6.02)	9.75 (5.96)*	12.18 (6.03)*	<0.001
Change score	–6.81 (8.06)	–6.81 (6.43)	–4.00 (5.71)	–3.36 (5.95)	0.034
WOMAC – stiffness					
Baseline	4.73 (2.04)	6.41 (3.73)*	5.06 (2.26)	5.67 (1.97)	0.030
One year postop	2.59 (6.50)	2.62 (2.29)	3.81 (2.17)*	4.09 (2.63)	0.003
Change score	–2.13 (6.88)	–3.71 (3.75)	–1.33 (2.26)	–1.91 (2.84)	NS
WOMAC – function					
Baseline	39.18 (14.63)	47.64 (14.83)	40.44 (16.20)	51.42 (13.39)*	0.007
One year postop	15.34 (17.81)	17.29 (16.35)	33.19 (18.85)*	38.36 (23.18)*	<0.001
Change score	–23.77 (22.04)	–29.38 (21.42)	–9.67 (18.78)*	–15.64 (23.22)	0.017
WOMAC – total					
Baseline	55.50 (19.05)	67.68 (20.93)	58.67 (21.84)	72.17 (18.07)*	0.004
One year postop	21.20 (18.72)	26.57 (23.28)	46.75 (25.78)*	54.64 (31.48)*	<0.001
Change score	–34.41 (24.71)	–39.95 (28.16)	–14.93 (24.70)*	–20.91 (31.12)	0.013

MDD = major depressive disorder; WOMAC = Western Ontario and McMaster University Arthritis Index.
*Signifies a significant difference from the No MDD group.

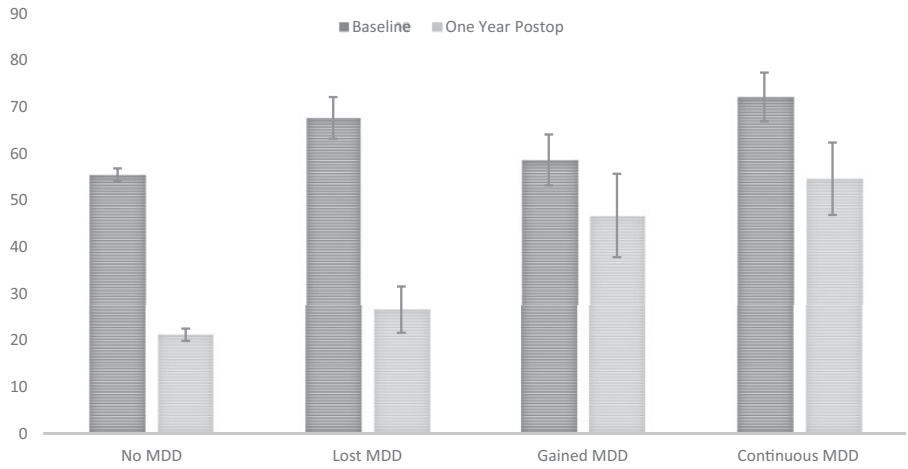

Figure 1. Western Ontario and McMaster University Arthritis Index total comparisons preoperatively and postoperatively.

assessment, there was only a significant group difference between the No MDD and Continuous MDD groups on the knee score measure. However, group differences were present in all Knee Society measures at 12-month follow-up. The overall change score showed significant group differences on all measures of Knee Society Score; this

Table 4. Knee society comparisons

Knee Society Mean (SD)	No MDD N = 202	Lost MDD N = 22	Gained MDD N = 17	Continuous MDD N = 12	Statistical Comparison, *P* Value
Knee Society – knee score					
Baseline	47.19 (16.19)	42.95 (20.22)	45.47 (18.24)	34.33 (11.40)*	0.022
One year postop	80.86 (17.75)	79.84 (16.12)	66.81 (24.23)	46.70 (16.60)*,†	<0.001
Change score	33.76 (22.77)	36.00 (18.85)	29.00 (22.35)	15.60 (19.33)*	0.042
Knee Society – function					
Baseline	38.36 (17.77)	30.95 (13.88)	38.35 (26.82)	39.75 (24.99)	NS
One year postop	68.21 (21.94)	59.19 (20.45)	51.13 (23.11)*	39.36 (16.44)*	<0.001
Change score	30.43 (22.97)	26.29 (26.33)	18.27 (20.65)	2.55 (25.76)*	0.002
Knee Society – total					
Baseline	85.50 (28.15)	73.91 (33.00)	83.82 (37.89)	74.08 (32.10)	NS
One year postop	149.25 (24.27)	141.21 (31.63)	117.94 (42.10)*,†	84.60 (28.21)*	<0.001
Change score	64.25 (38.10)	65.63 (36.98)	47.27 (34.89)	18.80 (36.44)*	0.002

MDD = major depressive disorder.

*Denotes a significant post hoc difference from the No MDD group.

†Denotes a significant post hoc difference from the Lost MDD group.

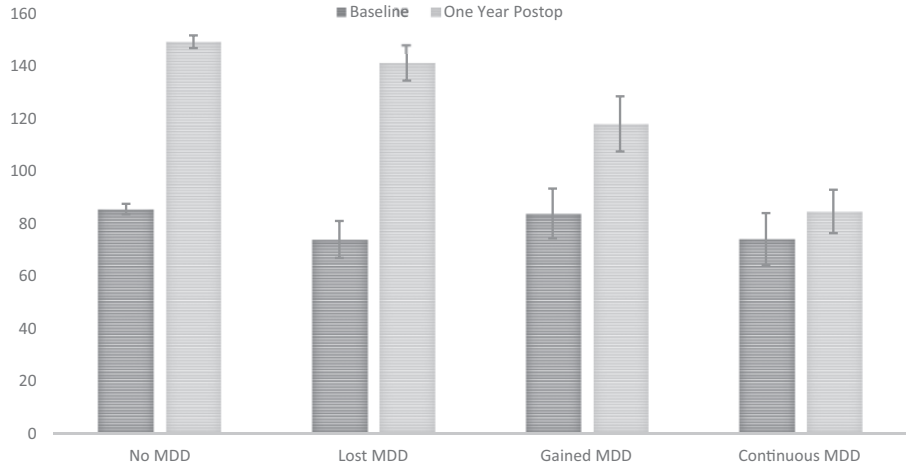

Figure 2. Knee Society Score total comparisons preoperatively and postoperatively.

suggests that the four groups do not have equal recovery following surgery. More specifically, the Continuous MDD group exhibited much less postoperative improvement when compared with the other three groups. Figure 2 represents the preoperative and postoperative Knee Society total scores for the four groups.

To determine the factors most associated with MDD at 12-month follow-up, a simultaneous binary logistic regression was conducted. Due to concerns of multicollinearity between the WOMAC and KSS measures, only the KSS total score was entered into the model as it directly assesses pain, function, and stiffness of the knee. Table 5 shows the one-year factors that were most associated with major depressive disorder. Caucasian patients were significantly more likely to meet the criteria for MDD at one-year follow-up vs African American, Hispanic, or other/not specified race/ethnicity. Patients with lower levels of mental quality of life and with greater pain on the KSS were more likely to meet the criteria for MDD at the one-year follow-up.

Discussion

Past research has had mixed findings on the relationship between MDD and TKA outcomes. In particular, studies have found that despite having poorer pain and function scores both preoperatively and postoperatively, there were similar net improvements from TKA [21,26]. This would suggest that TKA is still beneficial to patients with depression. However, most studies have relied on a depression diagnosis at the initial assessment when exploring potential consequences [4,8,11,20–26]. This approach is possibly flawed because it fails to take into account that depression could fluctuate throughout the duration of the study, which may confound the results. Thus, the current study was designed to examine the role of depression throughout the recovery period. More specifically, depression was measured at both the initial assessment and 12-month follow up. This allowed for the sample to be divided into four groups: individuals who had never had depression, individuals who no longer had

Table 5. Binary logistic regression assessing factors most associated with major depressive disorder at one-year follow-up

	P Value	Odds Ratio	95% CI Lower	95% CI Upper
Constant	0.000			
Age	0.400	0.968	0.899	1.043
Female gender	0.733	0.799	0.219	2.910
Race/ethnicity (ref. Caucasian)				
African American	0.048	0.103	0.011	0.980
Hispanic/Latino	0.015	0.058	0.006	0.568
Other/unknown	0.017	0.059	0.006	0.604
SF-36				
Mental health summary	0.000	0.889	0.843	0.939
Physical health summary	0.156	0.954	0.893	1.018
Knee Society				
Pain	0.002	0.952	0.924	0.982
Function	0.553	1.011	0.976	1.047

CI = confidence interval; SF-36 = Short-Form Health Inventory.

depression at the 12-month mark, individuals who gained depression at the 12-month assessment, and individuals who maintained depression throughout the 12-month period. To the best our knowledge, the current study is the first to examine depression at both the baseline and 12-month follow-up.

Depression has previously been linked to poor pain and function scores after TKA surgery [4,8,11,20–24]. These findings are further supported by the current study. On all postoperative measures, including the SF-36, Knee Society, and WOMAC assessments, individuals who had depression at the 12-month follow-up reported much lower scores than individuals who did not have depression. Furthermore, logistic regression reveals an association between depression and the Knee Society pain score. It remains unclear if the depression manifests due to the pain created by the knee or if depression is an underlying driver of poor functional recovery [20].

The most important result from this study is that there were between-group disparities in the net improvement following TKA surgery. This is especially seen when examining the Knee Society initial and follow-up assessments. At baseline, there were no significant group differences for knee function and total scores. However, there were differences present at the follow-up assessment, thus creating a disparity in recovery following surgery. In fact, patients who had depression at both the initial and the follow-up assessments experienced less than half the net change in Knee Society scores when compared with the three other groups. This gives a strong indication that TKA surgery was not nearly as beneficial to patients who did not improve their depression symptoms. In contrast, a similar net change can be seen in the group that had depression at initial assessment but not at the follow-up and the group that never had depression. Therefore, TKA surgery could be beneficial to individuals who have depression if they are properly treated for their mental health condition. Importantly, these findings are in contrast to previous studies that have suggested that depression does not impact net improvement during recovery [21,26]. The presence of depression at the time of the 12-month follow-up impacts postoperative outcomes. The significance of this finding is clinically important because the degree of pain, stiffness, and function being assessed by the WOMAC or KSS may not only be linked to physical healing but also ongoing psychosocial comorbidities.

One limitation of the current study is the small group sizes for the Lost MDD, Gained MDD, and Continuous MDD groups. This problem was in part due to missing data. Despite 412 patients completing the initial assessment, only 260 participants completed the necessary assessments at the 12-month follow-up. Another limitation is the lack of data collected regarding treatment for depression. It is possible that some participants received psychiatric treatment during the study that impacted their depression scores. A further limitation of this study is the failure to consider the analgesic regimens of the patients. It is unknown if the groups differed on their analgesic regimens.

Future studies on the disparity in recovery between patients with depression and patients without depression should consider the fluctuations with depression when considering TKA outcomes. Results of postoperative outcomes are difficult to interpret if depression is only measured at initial assessment because individuals who originally were successfully treated for depression have much different postoperative experiences than those whose depression remained constant. By analyzing the role of depression in this manner, the current study identified the Gained MDD group. These patients are of particular interest because their recovery appears to be stunted despite having favorable perioperative mental health factors. Perhaps these patients are developing depression because there is a mismatch between their recovery and their expectations. Alternatively, these patients may have been predisposed to developing depression regardless of TKA surgery. Future research is needed to identify patient factors contributing to the development of MDD postoperatively. Additionally, research is still

needed to determine if pain due to the knee is contributing to or causing the depression to manifest in the first place.

Conclusions

In summary, depression appears to be associated with poorer preoperative and postoperative TKA scores. Furthermore, individuals who were depressed 12 months after surgery demonstrated a poorer recovery than individuals who did not show depressive symptoms before TKA or within the year after. Importantly, individuals whose depression decreased in the 12 months after TKA benefited equally as much from surgery as those who had never had depression. Therefore, it is advisable that depressed patients undergo treatment for their depression either before surgery and/or during the recovery from TKA surgery.

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