

improve social and psychological well-being^{3,4}. Various assessment tools, including the Zurich Claudication Questionnaire (ZCQ), Oswestry Disability Index, EuroQol-5 Dimension, Roland-Morris Disability Questionnaire, and the Japanese Orthopaedic Association Back Pain Evaluation Questionnaire (JOABPEQ), are used for surgical outcome evaluation^{3,5,6}. Of these, the ZCQ, which consists of three subscales of symptom severity, physical function, and patient satisfaction, is commonly used as an index to evaluate surgical outcomes for LCS⁹. Furthermore, the JOABPEQ enables a detailed assessment for LCS patients across five domains: pain, lumbar function, walking ability, social life, and psychological health⁶.

Recently, patient satisfaction has gained prominence as a crucial measure for assuring patient-centered care⁷. Patient satisfaction is also an important outcome measure for LCS surgery. Although patient satisfaction with LCS surgery is largely dependent on surgical outcomes, it does not always align with other surgical outcome metrics⁸. Even though several causes were reported for LCS surgery satisfaction or dissatisfaction, the factors affecting patient satisfaction or dissatisfaction after LCS surgery remain poorly understood⁹⁻¹⁴. In particular, determining predictors of patient satisfaction or dissatisfaction is crucial for physician's decision of surgical indication and preoperative informed consent to LCS patient. This study aimed to examine the longitudinal characteristics of patient satisfaction in surgical LCS patients via a retrospective multicenter data analysis. We additionally sought to identify key predictors of LCS surgery dissatisfaction.

Materials and Methods

Study participants

We retrospectively reviewed the time-course data of patients aged 40 or above who underwent LCS surgery at multiple hospitals between April 2021 and March 2022. Surgery was indicated for patients with obvious LCS symptoms that were unresponsive to conservative treatments^{3,4}. The diagnostic procedures included magnetic resonance imaging, computerized tomography scans, and myelography. Lumbar spinal fusion was recommended for patients with lumbar spondylolisthesis. We excluded patients with an upper instrumented thoracic spine level or a lower instrumented pelvis level. Given the potential of degenerative lumbar scoliosis and failed back surgery syndrome as risk factors for patient satisfaction or dissatisfaction, we did not exclude patients with these conditions to analyze their involvement in this study.

Ethics approval

This study was approved by the ethics committees of each participating institution. Eligible patients, except those who wanted to opt out, were included. The study followed the guidelines proposed in the Declaration of Helsinki.

Data collection

All participants completed the ZCQ and JOABPEQ before surgery, at 6-months postsurgery, and at 1 year postsurgery. Collected data included age, sex, body mass index (BMI), medical history (e.g., diabetes mellitus, hypertension, dyslipidemia, cardiovascular disease, stroke, cancer, spondylolisthesis, degenerative lumbar scoliosis, failed back surgery syndrome [FBSS]), and perioperative variables such as surgical procedures, operated level, time, blood loss, and presence of dural tears.

Patient satisfaction

Patient satisfaction measures were similar to those described in earlier studies^{15,16} and categorized patient satisfaction using postoperative ZCQ scores. Patients who scored ≤ 2.0 were considered as satisfied (S group), patients who scored >2.0 but not >2.5 as "moderately" satisfied (M group), and patients who scored >2.5 as dissatisfied (D group).

Statistical analyses

Data among groups were compared using the chi-squared test, Wilcoxon signed-rank test, Kruskal-Wallis test, or nearest neighbor homogeneity test as appropriate. We determined which among age; sex; BMI; medical history including hypertension, dyslipidemia, and diabetes mellitus, cardiovascular disease, stroke, cancer, spondylolisthesis, degenerative lumbar scoliosis, and FBSS; surgical procedure; surgical levels; surgical time; surgical blood loss; and surgical dural tear; and preoperative score in five domains of the JOABPEQ, were associated with patient dissatisfaction 1 year postsurgery. Then, we constructed a Poisson regression model adjusted for age, sex, hospital, and factors associated with ZCQ satisfaction ($p < 0.05$ by chi-squared test) and estimated relative risks (RRs) and 95% confidence intervals (CIs) for patient dissatisfaction 1 year postsurgery. In this model, the JOABPEQ scores were categorized in tertiles according to a previous study¹⁷. Poisson regression was performed using the STATA16 software (Stata Corporation, College Station, TX, USA). The p values of < 0.05 were considered to indicate statistical significance. To determine whether the JOABPEQ scores could discriminate the D group 1 year postsurgery from the S and M groups, we calculated the area under the curve (AUC) based on the receiver operating characteristic curve (ROC) and used the cutoff point as the maximum value of the Youden index (sensitivity+specificity-1).

Results

Enrollment and results overview

The study successfully enrolled 241 patients. Table 1 presents their baseline characteristics. Supplementary Table 1 depicts the comparison of the ZCQ and JOABPEQ scores

Table 1. Baseline Characteristics.

Patients		n=241
Gender		Male: 104 Female: 137
Age (years)		69.5±10.5
BMI (kg/m ²)		24.0±3.6
Medical history	Diabetes mellitus	53 (22.0%)
	Hypertension	123 (51.0%)
	Dyslipidemia	95 (39.4%)
	Cardiovascular disease	56 (23.2%)
	Stroke	13 (5.4%)
	Cancer	22 (9.1%)
Spondylolisthesis		83 (34.4%)
Degenerative lumbar scoliosis		34 (14.1%)
FBSS		11 (4.6%)
Surgical procedure	without fusion	129 (53.5%)
	with fusion	112 (46.5%)
Surgical levels		1.8±0.9
Surgical time (min)		119.0±79.0
Surgical blood loss (mL)		112.9±147.0
Surgical dural tear		12 (5.0%)

FBSS, Failed back surgery syndrome

before surgery, at 6 months postsurgery, and at 1 year postsurgery. We observed significant improvements across all the ZCQ and JOABPEQ domains when we compared the 6-month and 1-year postoperative scores with the baseline data (Supplementary Table 1).

Patient satisfaction over time

Fig. 1A presents the distribution of patients categorized as satisfied, moderately satisfied, and dissatisfied at 6 months and 1 year postsurgery. The distribution did not significantly change between these two periods (Fig. 1A). When we examined group-specific changes in satisfaction starting at 6 months to 1-year postsurgery (Fig. 1B), we found that 47.6% of the patients who were dissatisfied at 6 months postsurgery showed improvements at the 1-year mark. The remaining 52.4% experienced no change in their satisfaction levels (Fig. 1B). In addition, 46.9% of patients who were moderately satisfied at 6 months postsurgery improved by the 1-year mark, 43.8% remained at the same level, and 9.4% worsened (Fig. 1B). Among patients who were satisfied at 6 months, 86.2% exhibited no change at 1 year, whereas the remaining 13.8% worsened (Fig. 1B).

Subgroup analysis and significant findings

In accordance with the satisfaction domain of the ZCQ, Table 2 demonstrates that 33 patients were “dissatisfied” (D group), 40 were “moderately satisfied” (M group), and 168 were “satisfied” (S group) at 1 year postsurgery. Among these groups, we observed significant differences in age ($p=0.008$) and the prevalence of FBSS ($p=0.031$). For pe-

rioperative factors, significant differences were observed among the groups in the type of surgical procedure ($p=0.002$), surgical time ($p=0.007$), and surgical blood loss ($p=0.002$) (Table 2). Table 3 further demonstrates significant disparities in the preoperative JOABPEQ scores across the three groups, particularly in the domains of lumbar function ($p<0.001$), walking ability ($p=0.009$), social life ($p=0.005$), and psychological disorders ($p<0.001$). Meanwhile, at both 6 months and 1 year postsurgery, all five domains of the JOABPEQ showed significant disparities among the groups (Table 3). However, in all the groups, the scores in all domains of the JOABPEQ basically showed an improvement at 6 months and 1 year postsurgery compared with the baseline. In the D group, the scores for the lumbar function domain exhibited a marginally significant difference ($p=0.057$) between baseline and 1 year postsurgery (Table 3). In the M group, the scores for the social life domain also showed a marginally significant difference ($p=0.084$) between baseline and 6 months postsurgery (Table 3). For all other score comparisons, statistically significant differences were observed (Table 3).

Factors associated with patient dissatisfaction

Using a Poisson regression model, we evaluated the factors that could be associated with patient dissatisfaction at 1 year postsurgery. After accounting for variables such as age, sex, hospital, and other factors associated with ZCQ satisfaction (with a $p<0.05$ as determined by chi-squared test), we found that age (RR, 0.5; 95% CI, 0.2-0.8) and a higher preoperative psychological disorder score on the JOABPEQ

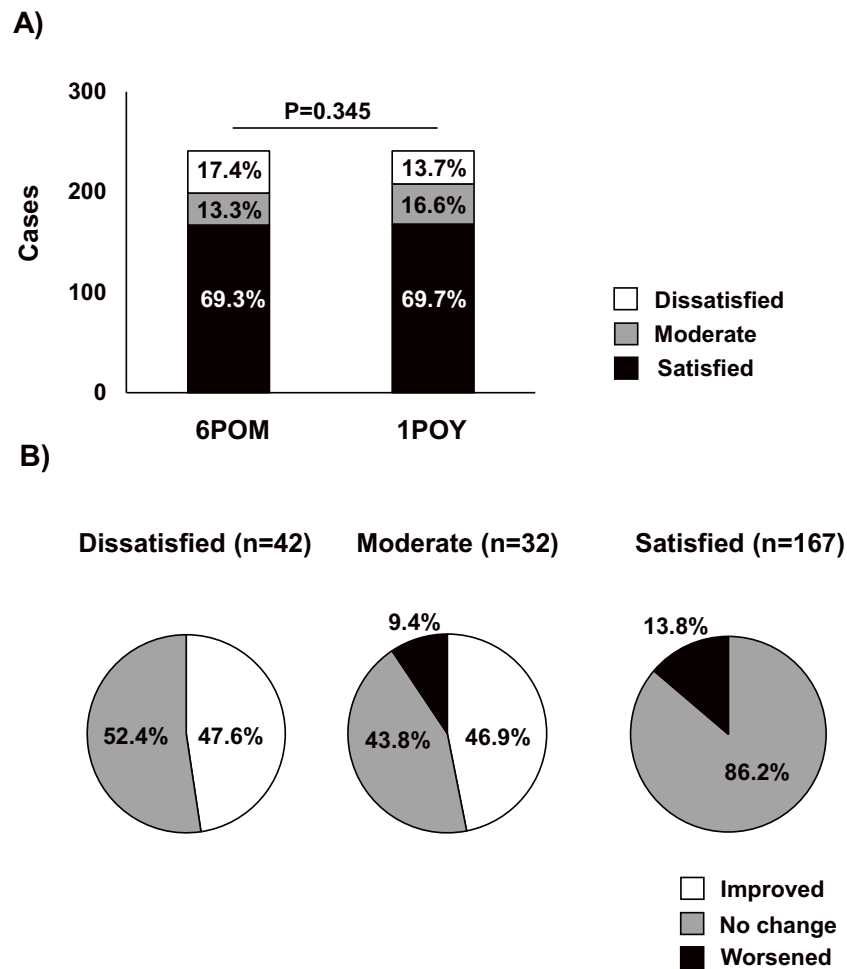


Figure 1. A: Distribution of patient satisfaction levels at 6 months and 1 year postsurgery. The categories are “Satisfied,” “Moderately Satisfied,” and “Dissatisfied.” No significant changes were observed in the distribution of these categories between the two time points: 6POM, 6 postoperative months, and 1POY, 1 postoperative year. B: Group-specific changes in patient satisfaction from 6 months to 1 year postsurgery.

(RR, 0.2; 95% CI: 0.03-0.8) were independently associated with dissatisfaction at 1 year postsurgery (Table 4). Considering that RR lower than 1 indicates that the factor is negatively associated with the dependent variable, these results indicate that the higher the scores of these two factors, the less likely postoperative dissatisfaction occurs.

Predictive accuracy of dissatisfaction factors

Finally, we tested the predictive accuracy for patient dissatisfaction based on psychological disorder scores from the preoperative JOABPEQ of each patient. The AUC for psychological disorders was 0.72 (with a 95% CI of 0.65-0.82), indicating a moderate level of predictive accuracy (Table 5). The cutoff value in the JOABPEQ psychological disorder score was 40, with a sensitivity of 66.4% and a specificity of 72.7% (Table 5).

Discussion

We observed a patient satisfaction rate of approximately

70% when defined by a ZCQ satisfaction subscale score of ≤ 2.0 . This is consistent with Yamamoto et al.’s finding of an 80% satisfaction rate using a ZCQ cutoff score of 2.5¹⁶⁾ and Ogura et al.’s 75% rate using a single ZCQ question¹⁴⁾. Although studies vary in their scales and cutoff values of LCS surgery satisfaction, previous literature demonstrated LCS surgery satisfaction rates fluctuating between 60% and 80%¹⁴⁻¹⁶⁾. Furthermore, our longitudinal analysis revealed that these rates remained stable between 6 months and 1 year postsurgery. However, around 50% of the initially dissatisfied or moderately satisfied patients showed improvement by 1 year. At 6 months postsurgery, some patients continued to experience residual neuropathic pain, numbness, and unhealed surgical pain, which may improve in the following 6 months. These results suggest that even if patients are dissatisfied with LCS surgery at 6 months postsurgery, they can be satisfied at another 6 months. Conversely, around 90% of patients satisfied at 6 months retained their satisfaction at 1 year, indicating that the physician can tell that patients who are satisfied with LCS surgery at 6 months postsurgery will

Table 2. Comparison of Baseline Characteristics among the Three Groups.

		Dissatisfied (n=33)		Moderate (n=40)		Satisfied (n=168)		p value
		Men	23 (69.7%)	Men	21 (52.5%)	Men	93 (55.4%)	
Gender		Women	10 (30.3%)	Women	19 (47.5%)	Women	75 (44.6%)	0.262
	Age (years)		68.6±10.5		74.4±7.9		68.6±10.7	
BMI (kg/m ²)		24.3±4.0		23.2±3.0		24.1±3.6		0.487
Medical history	Diabetes mellitus	11 (33.3%)		11 (27.5%)		31 (18.5%)		0.110
	Hypertension	23 (69.7%)		20 (50.0%)		80 (47.6%)		0.116
	Dyslipidemia	15 (45.4%)		13 (32.5%)		67 (40.0%)		0.517
	Cardiovascular disease	12 (36.4%)		7 (17.5%)		37 (22.0%)		0.131
	Stroke	2 (6.1%)		1 (2.5%)		10 (6.0%)		0.674
	Cancer	2 (6.1%)		4 (10.0%)		16 (9.5%)		0.801
Spondylolisthesis		9 (27.3%)		13 (32.5%)		61 (36.3%)		0.583
Degenerative lumbar scoliosis		7 (21.2%)		4 (10.0%)		23 (13.7%)		0.376
FBSS		1 (3.0%)		5 (12.5%)		5 (3.0%)		0.031
Surgical procedure	without fusion	14 (42.4%)		20 (50.0%)		95 (56.5%)		0.002
	with fusion	19 (57.6%)		20 (50.0%)		73 (43.5%)		
Surgical levels		1.8±0.9		1.9±1.0		1.8±0.9		0.937
Surgical time (min)		133.7±72.9		145.3±97.4		109.7±73.7		0.007
Surgical blood loss (mL)		140.2±140.4		146.1±128.3		99.5±151.2		0.002
Surgical dural tear		1 (3.0%)		4 (10.0%)		7 (4.2%)		0.268

FBSS, Failed back surgery syndrome

Pearson's chi-squared test or Kruskal-Wallis test was used.

be fine for the next 6 months.

Various factors associated with LCS surgery satisfaction or dissatisfaction have been previously reported⁹⁻¹⁴. Paulsen et al. reported that patient satisfaction is basically proportional to the results of surgical outcome measures¹³. In patient-specific factors, smoking status, obesity, unemployment, back pain predominance, psychological distress, greater medical comorbidity, and long duration of leg pain have been previously reported to be associated with LCS surgery satisfaction or dissatisfaction¹⁰⁻¹⁴. In this study, multivariate analysis clearly revealed that age and psychological disability emerged as significant predictors of dissatisfaction. Interestingly, older patients were less often dissatisfied, contradicting expectations given their greater medical comorbidities. A previous study found that relatively “younger” patients, aged 75 and below, were more satisfied after LCS surgery¹⁸; however, age is not currently considered a strong prognostic indicator for patients undergoing LCS surgery⁴. Although it remains unclear why we found less dissatisfaction with LCS surgery among older patients, our results may be encouraging for older patients considering surgery. Meanwhile, psychological disorders are consistently associated with post-LCS surgery dissatisfaction^{10,16}. In this study, ROC analysis provided a JOABPEQ psychological disorder score cutoff value, which, while not highly accurate, provides clinical utility. Predictors of patient satisfaction with LCS surgery are important for surgical decision making and in-

formed consent. Both patients and healthcare providers need to be aware of these predictors to make the best-informed treatment choice. Although preoperative plans and successful surgeries improve patient satisfaction, those with realistic expectations were more satisfied than those with either overly optimistic or pessimistic views toward treatment outcomes^{19,20}. Therefore, aligning patient expectations with realistic treatment outcomes is also crucial during the preoperative informed consent process. Furthermore, effective patient-provider communication is a key determinant of patient satisfaction²¹. Patients who feel well-informed and engaged in the decision-making process tend to express higher satisfaction²². These findings suggest that patient satisfaction is influenced by surgical outcomes, patient-specific factors, and positive patient-provider communication.

This study has some limitations. First, the 1-year follow-up period is likely insufficient for assessing patient satisfaction with LCS surgery because over time, patient satisfaction may change; however, our results exhibited a trend of durability in patient satisfaction between 6 months and 1 year, so further studies are warranted. Second, different surgeries—such as decompression and fusion with different degrees of invasiveness—were used. Although a single procedure might be better for analyzing LCS surgery satisfaction, the surgical plans were at the patients' and providers' discretion and therefore reflect “real-world” conditions with patient-specific surgical procedures. Third, the study cohort

Table 3. Valuables of JOABPEQ at Baseline and Follow-up after Surgery among the Three Groups.

		Dissatisfied (n=33)	Moderate (n=40)	Satisfied (n=168)	*p value
Preoperation	Pain disorder	29 (0–57)	43 (14–61)	43 (14–71)	0.172
	Lumbar function	33 (23–69)	38 (25–69)	67 (42–83)	<0.001
	Walking ability	21 (0–43)	21 (5–29)	29 (7–50)	0.009
	Social life	24 (11–46)	38 (32–51)	46 (29–51)	0.005
	Psychological disorder	36 (18–43)	39 (30–48)	48 (39–56)	<0.001
6POM	Pain disorder	43 (14–100)	71 (43–100)	100 (71–100)	<0.001
	Lumbar function	58 (42–83)	58 (42–83)	83 (75–100)	<0.001
	Walking ability	43 (21–64)	43 (29–71)	93 (71–100)	<0.001
	Social life	43 (32–57)	51 (32–57)	78 (57–100)	<0.001
	Psychological disorder	43 (36–53)	50 (45–54)	66 (55–78)	<0.001
1POY	Pain disorder	43 (14–100)	71 (43–100)	100 (82–100)	<0.001
	Lumbar function	50 (33–83)	67 (40–83)	83 (83–100)	<0.001
	Walking ability	43 (21–64)	50 (29–71)	93 (71–100)	<0.001
	Social life	35 (27–51)	51 (32–65)	78 (57–100)	<0.001
	Psychological disorder	41 (27–51)	49 (42–58)	69 (57–80)	<0.001
**p value	Preoperation vs. 6POM				
	Pain disorder	0.040	<0.001	<0.001	
	Lumbar function	0.002	<0.001	<0.001	
	Walking ability	0.001	<0.001	<0.001	
	Social life	0.005	0.084	<0.001	
Preoperation vs. 1POY	Psychological disorder	<0.001	<0.001	<0.001	
	Pain disorder	0.033	<0.001	<0.001	
	Lumbar function	0.057	0.002	<0.001	
	Walking ability	0.008	<0.001	<0.001	
	Social life	0.014	0.035	<0.001	
Psychological disorder	0.007	<0.001	<0.001		

JOABPEQ, JOA Back Pain Evaluation Questionnaire; 6POM, 6 postoperative months; 1POY, 1 postoperative year

*Kruskal-Wallis test, **Wilcoxon signed-rank test.

had no uniform postoperative care. Adequate access to postoperative rehabilitation services and social support networks improves patient satisfaction^{23,24}. Unifying postoperative care in the study cohort could more accurately identify patient factors predicting LCS surgery satisfaction or dissatisfaction; however, we were limited by the retrospective and multicenter nature of this study. However, this study clearly demonstrated the longitudinal characteristics of satisfaction in surgical LCS patients and the predictors of LCS surgery dissatisfaction.

In conclusion, at both 6 months and 1 year postsurgery, about 70% of patients were satisfied with their LCS procedure. Nearly half of those dissatisfied at 6 months reported improvement by 12 months, whereas the majority of initially satisfied patients remained so. Age and psychological disorders were identified as significant predictors of dissatisfaction, with a JOABPEQ cutoff value providing potential clinical applicability.

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Table 4. Poisson Regression Model of Patient Dissatisfaction at 1-year Postsurgery.

		No. of participants	No. of outcome	Incidence (%)	<i>p</i> value by chi-squared test	Multivariable model*			
						Relative risk (RR)	95% Confidence interval (CI)		<i>p</i> value
Age	<65	73	14	19.2	0.10	Reference			
	65-	168	19	11.3		0.5	0.2	0.8	0.01
Sex	Women	104	10	9.6	0.11	Reference			
	Men	137	23	16.8		1.5	0.8	2.9	0.23
BMI (kg/m ²)	<25.0	162	17	10.5	0.04	Reference			
	≥25.0	79	16	20.3		1.5	0.8	2.9	0.21
Hypertension	No	118	10	8.5	0.02	Reference			
	Yes	123	23	18.7		2.0	0.9	4.1	0.08
Dyslipidemia	No	146	18	12.3	0.45				
	Yes	95	15	15.8					
Diabetes mellitus	No	188	22	11.7	0.09				
	Yes	53	11	20.8					
Cardiovascular disease	No	185	21	11.4	0.06				
	Yes	56	12	21.4					
Cerebrovascular disease	No	228	31	13.6	0.86				
	Yes	13	2	15.4					
Cancer	No	219	31	14.2	0.51				
	Yes	22	2	9.1					
Spondylolisthesis	No	158	24	15.2	0.35				
	Yes	83	9	10.8					
Degenerative lumbar scoliosis	No	207	26	12.6	0.21				
	Yes	34	7	20.6					
FBSS	No	230	32	13.9	0.65				
	Yes	11	1	9.1					
Surgical procedure	Without fusion	129	14	10.9	0.17				
	With fusion	112	19	17.0					
Surgical levels	1	107	13	12.2	0.30				
	2	75	14	18.7					
	3, 4, 5	59	6	10.2					
Surgical time (min)	<180	208	27	13.0	0.42				
	≥180	33	6	18.2					
Surgical blood loss (mL)	<400	230	32	13.9	0.65				
	≥400	11	1	9.1					
Surgical dural tear	No	229	32	14.0	0.58				
	Yes	12	1	8.3					
JOABPEQ									
Pain disorder	Tertile1 (score <15)	78	14	18.0	0.33				
	Tertile2	82	11	13.4					
	Tertile3 (score >57)	81	8	9.9					
Lumbar function	Tertile1 (score <34)	76	17	22.3	0.02	Reference			
	Tertile2	73	9	12.3		0.9	0.4	1.8	0.71
	Tertile3 (score >67)	92	7	7.6		0.7	0.3	1.6	0.42
Walking ability	Tertile1 (score <15)	87	16	18.4	0.23				
	Tertile2	60	8	13.3					
	Tertile3 (score >36)	94	9	9.6					
Social life	Tertile1 (score <31)	77	20	26.0	<0.01	Reference			
	Tertile2	79	7	8.9		0.6	0.3	1.2	0.13
	Tertile3 (score >50)	85	6	7.1		0.6	0.2	1.3	0.20
Psychological disorder	Tertile1 (score <39)	80	20	25.0	<0.01	Reference			
	Tertile2	82	11	13.4		0.7	0.4	1.4	0.29
	Tertile3 (score >50)	79	2	2.5		0.2	0.03	0.8	0.03

* Model: adjusted for age, sex, hospital, and factors associated with ZCQ satisfaction (*p*<0.05 by chi-squared test).

JOABPEQ, JOA Back Pain Evaluation Questionnaire; FBSS, Failed back surgery syndrome

Table 5. Cutoff Value for Patient Dissatisfaction at 1-year Postsurgery.

	AUC	Cutoff value	Sensitivity (%)	Specificity (%)
Psychological disorder	0.72 (95% CI=0.65–0.82)	40	66.4	72.7

AUC, area under the curve

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