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MSCT evaluation of lipiodol uptake in predicting recurrence of hepatocellular carcinoma after TACE

Xu Lei
Guannan Branch of the First People's Hospital of Lianyungang City
Ji Tingju
jitingju321654@126.com

Guannan Branch of the First People's Hospital of Lianyungang City
Meng Lingxiao
Guannan Branch of the First People's Hospital of Lianyungang City
Zhou Changwu
Affiliated Hospital of Yangzhou University
Tang Zhi
Guannan Branch of the First People's Hospital of Lianyungang City
Zhou Shengli
the first people's Hospital of Lianyungang

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Abstract

Objective

To investigate the clinical application value of multi-slice spiral CT (MSCT) in predicting tumor recurrence in patients with liver cancer after transcatheter arterial chemoembolization (TACE).

Methods

The clinical and imaging data of 120 patients with liver cancer treated with TACE from January 2020 to December 2025 were retrospectively analyzed. All patients underwent MSCT enhanced scan one month after TACE. Two imaging physicians with high professional titles independently evaluated the uptake of lipiodol in the tumor. According to the shape and scope of lipiodol deposition, they were divided into complete filling type, partial filling type and small filling type. The recurrence rate at 6 months and 12 months after TACE was recorded. Kaplan Meier method was used to analyze the survival rate. Log rank test was used to compare the recurrence free survival (RFs) of patients with different degrees of lipiodol intake. Cox proportional hazards regression model was used to analyze the risk factors for recurrence of liver cancer after TACE.

Results

Among the 120 patients, 32 cases (26.7%) were completely filled with Lipiodol, 58 cases (48.3%) were partially filled with Lipiodol, and 30 cases (25.0%) were slightly filled with lipiodol. 28 cases recurred after 6 months of follow-up, 56 cases recurred after 12 months. Kaplan - Meier survival analysis and log - rank test showed that the 6-month RFs rates of patients with complete filling, partial filling and small filling were 87.5% (28g32), 60.3% (35/58) and 26.7% (8/30), respectively, and the 12-month RFs rates were 71.9% (23/32), 39.7% (23/58) and 20.0% (6/30), respectively. The median recurrence free survival was 14.5 months, 9.2 months and 5.8 months, respectively. There were significant differences in RFs among the three groups (log-rank χ^2=18.752, P < 0.001).2). The RFs of patients with complete filling was significantly longer than that of patients with partial filling and small filling (both P < 0.05), and the RFs of patients with partial filling was significantly longer than that of patients with small filling (P < 0.05). Cox multivariate analysis showed that the degree of lipiodol intake (small filling type vs complete filling type: 0 *HR* = 3.026,95%*CI*: 1.608–5.692, P < 0.001; Partial filling vs complete filling: *HR* = 1.872, 95% *CI*: 1.025–3.416, P = 0.041) and maximum tumor diameter ≥ 5 cm (*HR* = 2.135, 95% *CI*: 1.247–3.658, P = 0.006) were independent risk factors for postoperative recurrence (all P < 0.05).

Conclusion

MSCT evaluation of lipiodol uptake after TACE for liver cancer can effectively predict the risk of tumor recurrence. The less lipiodol uptake, the higher the risk of recurrence, and the shorter the recurrence free survival time. At the same time, the maximum tumor diameter (≥ 5 cm) is also an important independent risk factor for recurrence. In order to improve the prognosis of patients with liver cancer after TACE, individualized follow-up and adjuvant therapy can be formulated in combination with the results of MSCT lipiodol uptake assessment and tumor size.

Introduction

Hepatocellular carcinoma (HCC) is one of the most common malignant tumors globally, with high incidence and mortality rates [1]. Transcatheter arterial chemoembolization (TACE) is the first-line treatment widely used in clinical practice for patients with unresectable intermediate to advanced hepatocellular carcinoma [2]. The principle of TACE involves embolizing the tumor-feeding arteries to cut off the blood supply to the tumor while locally delivering chemotherapeutic agents, thereby inhibiting tumor growth and prolonging patient survival [3]. Iodized oil, a commonly used embolic agent in TACE, selectively deposits within tumor tissues. Its uptake and deposition in tumors are generally regarded as important indicators for evaluating TACE efficacy and predicting tumor prognosis [4]. Multislice spiral computed tomography (MSCT) offers advantages such as fast scanning speed, high spatial resolution, and robust post-processing capabilities, making it the primary imaging modality for assessing iodized oil deposition after TACE [5]. This study aims to investigate the relationship between the degree of iodized oil uptake evaluated by MSCT and tumor recurrence in hepatocellular carcinoma patients after TACE, with the goal of providing a reference for predicting recurrence risk and optimizing treatment strategies in clinical practice.

1 Materials and Methods

1.1 General Information

A retrospective collection was conducted on patients diagnosed with hepatocellular carcinoma (HCC) and treated with TACE from January 2020 to December 2025 at the Guannan Branch of Lianyungang First People's Hospital, Lianyungang First People's Hospital, and the Affiliated Hospital of Yangzhou University. Inclusion criteria: (1) diagnosed with primary hepatocellular carcinoma by histopathological examination or clinical imaging (such as MRI, CT combined with alpha-fetoprotein, etc.); (2) receiving TACE treatment for the first time; (3) undergoing MSCT contrast-enhanced scan one month after TACE; (4) having complete clinical and imaging data. Exclusion criteria: (1) combined with severe heart, liver, kidney, or other major organ failure; (2) presence of other malignant tumors; (3) failure to undergo MSCT examination within the specified timeframe after TACE or lack of follow-up data. A total of 120 patients were included, comprising 85 males and 35 females; aged 38–76 years, with an average of (56.3 ± 8.7) years. The maximum tumor diameter ranged from 1.8 to 10.5 cm, with an average of (5.2 ± 2.1) cm. Child-Pugh classification: Grade A in 101 cases, Grade B in 19 cases.

1.2 Methods

1.2.1 TACE Treatment Method

The Seldinger technique was used for all patients. After femoral artery puncture and catheterization, the catheter was superselectively placed into the tumor-feeding artery. According to the tumor size and blood supply, an appropriate amount of an emulsion containing chemotherapeutic agents (such as pirarubicin, oxaliplatin, etc.) and iodized oil (Lipiodol Ultra-Fluid, Guerbet, France) was injected. If necessary, this was combined with gelatin sponge particles or microspheres for embolization until blood flow stagnation in the tumor-feeding artery was achieved.

1.2.2 MSCT Examination Method

All patients underwent contrast-enhanced abdominal MSCT scans one month after TACE using a multislice spiral CT scanner (Model: Siemens Somatom Definition AS, 64-slice). Scanning parameters: tube voltage was set at 120 kV, tube current used automatic mAs technique, slice thickness and interval were both 5 mm, and pitch was 1.0. For the contrast-enhanced scan, a non-ionic contrast agent (Iohexol, 300 mgI/ml) was injected via the antecubital vein using a high-pressure injector at a dose of 1.5 ml/kg and a flow rate of 3.0–3.5 ml/s. Three-phase scanning was performed at 25–30 s (arterial phase), 60–70 s (portal venous phase), and 180–240 s (delayed phase) after contrast injection. The original data were reconstructed with thin slices: slice thickness 1.0–1.25 mm, slice interval 0.5–1.0 mm, using a soft tissue reconstruction algorithm.

1.2.3 Assessment of Iodized Oil Uptake Degree

Two senior radiologists with over 5 years of experience in abdominal imaging diagnosis independently reviewed the images to assess the degree of iodized oil uptake within the tumor. In case of disagreement, a consensus was reached through discussion. Based on the morphology and extent of iodized oil deposition, it was classified into the following three types: (1) Complete filling type: iodized oil uniformly and densely fills the entire tumor without significant defect areas (Fig. 1A); (2) Partial filling type: iodized oil fills 50%–99% of the tumor volume, with scattered or small patchy defect areas visible (Fig. 1B); (3) Minimal filling type: iodized oil fills < 50% of the tumor volume, or appears as sparse patchy or streak-like distribution (Fig. 1C).

Note

1A: Fully filled type; 1B: Partially filled type; 1C: Slightly filled type.

Figure 1 Abdominal CT image of the patient

1.2.4 Follow-up

All patients were regularly followed up postoperatively through methods including outpatient reviews and telephone follow-ups. Follow-up content included liver function, alpha-fetoprotein, and imaging

examinations (MSCT or MRI). The follow-up period ended in December 2025, and tumor recurrence status at 6 and 12 months after surgery was recorded. Tumor recurrence was defined as the appearance of new lesions, enlargement of existing lesions, or the emergence of viable tumor as detected by imaging (CT or MRI).

1.3 Statistical Methods

Data analysis was performed using SPSS 20.0 statistical software. Measurement data are presented as mean ± standard deviation, and count data as number (percentage). Inter-group comparisons were conducted using the χ^2 test. Recurrence-free survival (RFS) curves were plotted using the Kaplan-Meier method, and differences in RFS among patients with different degrees of iodized oil uptake were compared using the Log-rank test. The Cox proportional hazards regression model was employed to analyze risk factors influencing tumor recurrence after TACE for hepatocellular carcinoma. A P value < 0.05 was considered statistically significant.

2 Results

2.1 Comparison of General Information Among Patients with Different Degrees of Iodized Oil Uptake

Among the 120 patients, the degree of iodized oil uptake was classified as complete filling in 32 cases (26.7%), partial filling in 58 cases (48.3%), and minimal filling in 30 cases (25.0%). There were no statistically significant differences among the three groups in terms of gender, age, or Child-Pugh grade (P > 0.05). However, regarding maximum tumor diameter, the maximum tumor diameter in the minimal filling group was significantly larger than that in the complete filling and partial filling groups (P < 0.05), while no statistically significant difference was found between the complete filling and partial filling groups (P > 0.05). Table 1.

Table 1
Comparison of baseline characteristics among patients with different degrees of lipiodol uptake

Item	Complete Filling Type (n = 32)	Partial Filling Type (n = 58)	Minimal Filling Type (n = 30)	Statistic (F/χ^2)	*P*
Gender [n(%)]				0.032[1]	> 0.05
Male	28 (87.5)	50 (86.2)	26 (86.7)		
Female	4 (12.5)	8 (13.8)	4 (13.3)		
Age (years)	55.3 ± 8.7	57.1 ± 9.2	56.5 ± 8.9	0.421[2]	> 0.05
Maximum Tumor Diameter (cm)	4.2 ± 1.1	4.5 ± 1.3	6.8 ± 1.7*#	8.356[2]	< 0.05
Child-Pugh Class [n(%)]				0.654[1]	> 0.05
Grade A	28 (87.5)	49 (84.5)	24 (80.0)		
Grade B	4 (12.5)	9 (15.5)	6 (20.0)		

Note: Compared with the complete filling type, *P < 0.05; compared with the partial filling type, #P < 0.05. ¹ denotes χ^2 value; ² denotes F value. Measurement data are expressed as mean ± standard deviation, and count data as number (percentage).

2.2 Comparison of Tumor Recurrence Among Patients with Different Degrees of Iodized Oil Uptake

During the follow-up period, tumor recurrence occurred in 56 out of 120 patients (46.7%). Specifically, recurrence was observed in 8 patients (25.0%) in the complete filling group, 28 patients (48.3%) in the partial filling group, and 20 patients (66.7%) in the minimal filling group. The difference in tumor recurrence rates among the three groups was statistically significant ($\chi^2 = 12.364$, P = 0.002).
Table 2.Further pairwise comparisons showed that the recurrence rate in the minimal filling group was significantly higher than that in both the complete filling and partial filling groups (P < 0.05), and the recurrence rate in the partial filling group was significantly higher than that in the complete filling group (P < 0.05).

Table 2
Comparison of tumor recurrence among patients with different degrees of lipiodol uptake

Group	n	Recurrent Cases	Recurrence Rate (%)	*P* (vs. Complete Filling)
Complete Filling Type	32	8	25.0	—
Partial Filling Type	58	28	48.3	< 0.05
Minimal Filling Type	30	20	66.7	< 0.05
Total	120	56	46.7	χ^2=12.364, P = 0.002

Note: Pearson's χ^2 test was used to compare the tumor recurrence rates among the three groups, revealing a statistically significant difference (χ^2=12.364, P = 0.002).

2.3 Comparison of Recurrence-Free Survival Among Patients with Different Degrees of Iodized Oil Uptake

The Kaplan-Meier survival analysis showed that the median recurrence-free survival (median RFS) for patients in the complete filling, partial filling, and minimal filling groups was 14.5 months, 9.2 months, and 5.8 months, respectively. The recurrence-free survival curves are plotted in **Fig. 2.** The Log-rank test results indicated a statistically significant difference in RFS among the three groups (χ^2 = 18.752, P < 0.001). The RFS of patients in the complete filling group was significantly longer than that in both the partial filling and minimal filling groups (P < 0.05), and the RFS of patients in the partial filling group was significantly longer than that in the minimal filling group (P < 0.05). Table 3.

Note

RFS denotes Recurrence-Free Survival. A more gradual decline in the survival curve corresponds to a longer duration of recurrence-free survival.

Table 3
Comparison of recurrence-free survival among patients with different degrees of lipiodol uptake

Group	n	6-month RFS Rate (%)	12-month RFS Rate (%)	Median RFS (months)	95% CI (months)
Complete Filling Type	32	87.5	71.9	14.5	12.8–16.2
Partial Filling Type	58	60.3	39.7	9.2	7.9–10.5
Minimal Filling Type	30	26.7	20.0	5.8	4.3–7.3

Note: The comparison of RFS among the three groups was performed using the Log-rank test, and the difference was statistically significant ($\chi^2 = 18.752$, $P < 0.001$).

2.4 Multivariate Cox Regression Analysis of Recurrence after TACE for Hepatocellular Carcinoma

Taking tumor recurrence as the dependent variable (occurrence = 1, non-occurrence = 0), indicators with $P < 0.05$ in the univariate analysis (maximum tumor diameter, degree of iodized oil uptake) and clinically considered potential influencing factors (Child-Pugh grade) were included as independent variables in the Cox proportional hazards regression model. The assignment for independent variables was as follows: maximum tumor diameter (< 5 cm = 0, ≥ 5 cm = 1); degree of iodized oil uptake (complete filling type = 0, partial filling type = 1, minimal filling type = 2); Child-Pugh grade (Grade A = 0, Grade B = 1). The results showed that a maximum tumor diameter ≥ 5 cm (HR = 2.135, 95% CI: 1.247–3.658, P = 0.006), iodized oil uptake degree being partial filling type (HR = 1.872, 95% CI: 1.025–3.416, P = 0.041), and minimal filling type (HR = 3.026, 95% CI: 1.608–5.692, P < 0.001) were independent risk factors affecting tumor recurrence after TACE for HCC (all $P < 0.05$), while Child-Pugh grade was not an independent risk factor ($P > 0.05$). Table 4.

Table 4
Multivariate Cox regression analysis of factors associated with recurrence after TACE for hepatocellular carcinoma

Variable	Assignment / Comparison	HR (95% CI)	P
Maximum Tumor Diameter	≥ 5 cm vs. <5 cm	2.135 (1.247–3.658)	0.006
Degree of Lipiodol Uptake			
Partial Filling Type	vs. Complete Filling Type	1.872 (1.025–3.416)	0.041
Minimal Filling Type	vs. Complete Filling Type	3.026 (1.608–5.692)	< 0.001
Child-Pugh Class	Grade B vs. Grade A	1.240 (0.715–2.150)	0.445

Note

HR, hazard ratio; CI, confidence interval.

3 Discussion

Transcatheter arterial chemoembolization (TACE), as a crucial treatment for intermediate to advanced hepatocellular carcinoma, has its efficacy closely associated with the deposition of iodized oil within the tumor [6]. Iodized oil, serving as both an embolic agent and a carrier for chemotherapeutic drugs, can selectively lodge within tumor vasculature, killing tumor cells through the dual mechanisms of physical embolization and chemotherapy [7]. The results of this study showed that among 120 HCC patients treated with TACE, 26.7% achieved a complete filling pattern of iodized oil uptake, 48.3% a partial filling pattern, and 25.0% a minimal filling pattern. This distribution is largely consistent with reports from most previous studies [8], indicating that a considerable proportion of patients in clinical practice still fail to achieve an ideal level of iodized oil filling.

This study first compared the general information of patients with different degrees of iodized oil uptake. No significant differences were found among the three groups regarding gender, age, or Child-Pugh grade, suggesting that the degree of iodized oil uptake may not be significantly influenced by these baseline clinical characteristics. However, regarding maximum tumor diameter, the tumors in the minimal filling group were significantly larger than those in the complete and partial filling groups. This result implies that a larger tumor volume may be an important factor hindering adequate iodized oil filling [9]. Larger tumors often have a richer and more complex blood supply, potentially involving multiple feeding arteries or arteriovenous shunts, which increases the difficulty of embolization. Additionally, large tumors may contain necrotic or fibrotic areas internally, which can also affect the penetration and deposition of iodized oil [10].

Regarding tumor recurrence, the results of this study showed a gradual increase in recurrence rates as the degree of iodized oil uptake decreased. The recurrence rate in the minimal filling group was as high as 66.7%, significantly higher than that in the partial filling group (48.3%) and the complete filling group (25.0%). The recurrence rate in the partial filling group was also significantly higher than that in the complete filling group. This indicates a close correlation between the degree of iodized oil uptake and the risk of tumor recurrence after TACE for HCC: more complete iodized oil filling is associated with a lower recurrence rate [11]. This aligns with the therapeutic mechanism of iodized oil: adequate deposition can more thoroughly block tumor blood supply and kill tumor cells, thereby reducing residual or recurrent tumor foci [12].

Recurrence-free survival (RFS) is an important indicator for evaluating the efficacy of anti-tumor therapy. The Kaplan-Meier survival analysis in this study showed that the median RFS was longest in the complete filling group (14.5 months), followed by the partial filling group (9.2 months), and shortest in the minimal filling group (5.8 months), with statistically significant differences among the three groups. Further pairwise comparisons revealed significant differences in RFS between each pair, once again confirming the important influence of iodized oil uptake degree on the recurrence-free survival time of

HCC patients after TACE [13]. Patients achieving complete filling can attain a longer tumor-free survival period, which is of great significance for improving their quality of life and long-term prognosis.

To exclude interference from other factors and clarify whether the degree of iodized oil uptake is an independent risk factor affecting recurrence after TACE for HCC, a multivariate Cox proportional hazards regression analysis was performed. The results showed that, after adjusting for factors such as maximum tumor diameter, the degree of iodized oil uptake remained an independent risk factor for recurrence. Compared to the complete filling group, the risk of recurrence increased by 87% (HR = 1.872) in the partial filling group and approximately tripled (HR = 3.026) in the minimal filling group. Simultaneously, a larger maximum tumor diameter was also an independent risk factor for recurrence (HR = 2.135), meaning larger tumors are associated with a higher recurrence risk. This finding further highlights the important value of the degree of iodized oil uptake in predicting recurrence after TACE for HCC [14], suggesting that clinicians should place high importance on achieving the best possible embolization effect, i.e., optimal iodized oil filling, during the TACE procedure.

This study has certain limitations. First, as a single-center, retrospective study with a relatively limited sample size, there is a potential for selection bias. Second, the assessment of iodized oil uptake was primarily based on MSCT images. Although performed independently by two experienced radiologists with consensus resolution, it inherently carries a degree of subjectivity. Future studies could incorporate quantitative analysis methods to enhance the objectivity and accuracy of the assessment [15]. Furthermore, this study did not analyze in detail the factors influencing the degree of iodized oil uptake, such as tumor pathology, blood supply characteristics, or embolization techniques, which warrants further investigation.

In conclusion, the degree of iodized oil uptake within the tumor after TACE for hepatocellular carcinoma is closely related to the tumor recurrence rate and recurrence-free survival of patients. A lower degree of iodized oil uptake is associated with a higher risk of recurrence and shorter recurrence-free survival. Multivariate analysis indicates that the degree of iodized oil uptake is an independent risk factor for recurrence after TACE for HCC [14]. Therefore, in clinical practice, efforts should be made to maximize the degree of iodized oil filling within the tumor during TACE procedures to reduce the risk of postoperative recurrence and improve patient prognosis. Simultaneously, the degree of iodized oil uptake can serve as an important indicator for evaluating the efficacy of TACE and predicting postoperative recurrence, guiding the formulation of subsequent treatment plans. For patients with suboptimal iodized oil uptake, combination with other therapies, such as ablation, targeted drug therapy, or immunotherapy, should be considered to further enhance treatment efficacy.

Declarations

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by the Institutional Review Board of Guannan Branch of the First People's Hospital of Lianyungang City (Ethics Approval No: GN202001). All procedures performed in this study were in accordance with the ethical standards of the institutional research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Author contributions

Conception and design of the research: SL-Z and TJ-J. Acquisition of data: L-X, TJ-J, and LX-M. Analysis and interpretation of data: L-X and TJ-J. Statistical analysis: L-X, Z-T, and CW-Z. Funding acquisition: SL-Z and LX-M. Writing of the manuscript: L-X, TJ-J, and LX-M. Critical revision of the manuscript for intellectual content: SL-Z, TJ-J, and LX-M. All authors contributed to the article and approved the submitted version.

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Confiict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Figures

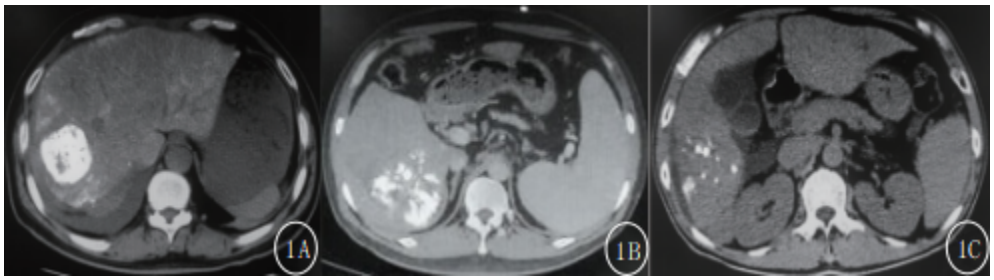

Figure 1

Abdominal CT image of the patient

Note: 1A: Fully filled type; 1B: Partially filled type; 1C: Slightly filled type.

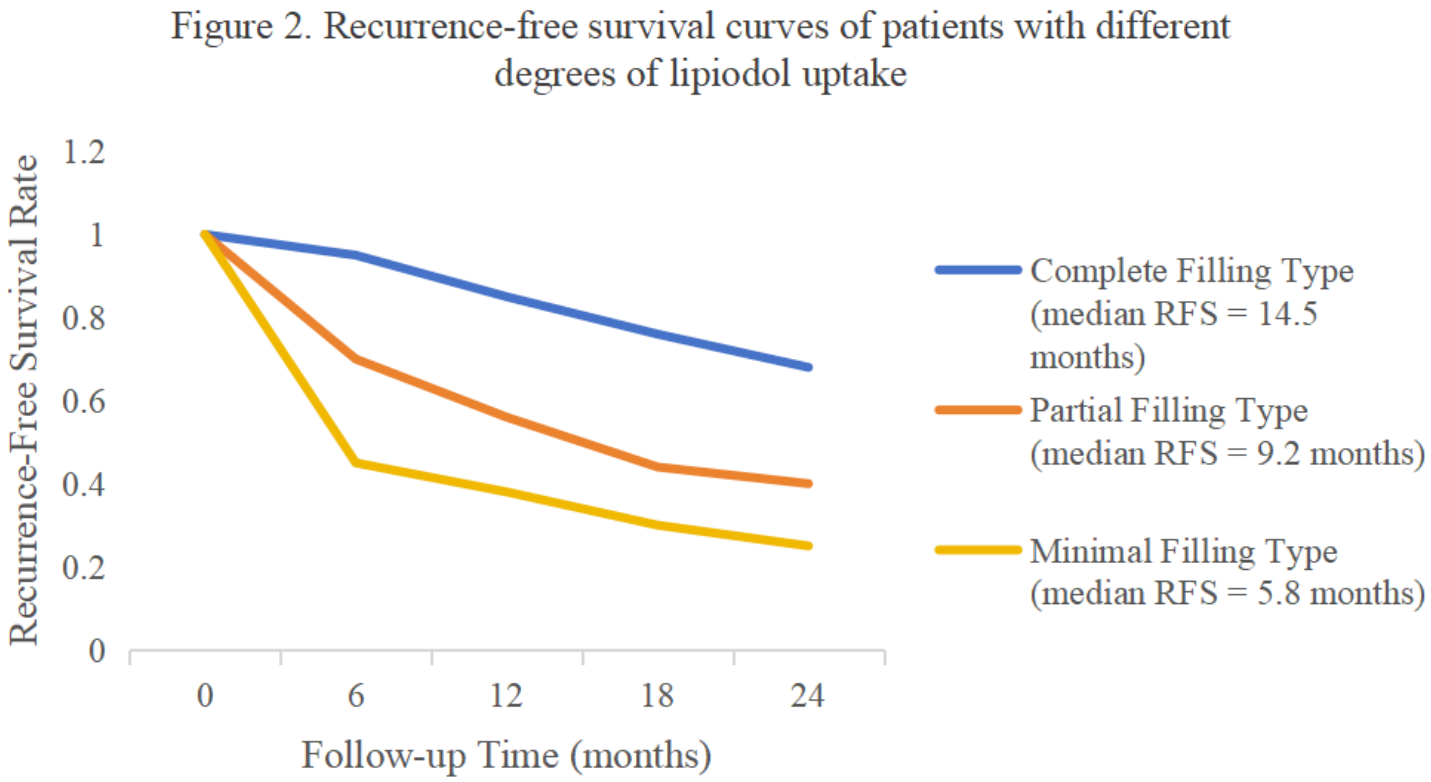

Figure 2

See image above for figure legend