The Type of Gastrectomy and Modified Frailty Index as Useful Predictive Indicators for One-Year Readmission Due to Nutritional Difficulty in Patients Who Undergo Gastrectomy for Gastric Cancer.

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Research Article

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Abstract

Background

Patients who undergo gastrectomy for gastric cancer are likely to have nutritional difficulty after surgery. Therefore, readmission due to nutritional difficulty is frequently observed in such patients. This study aimed to identify predictive indicators for readmission due to nutritional difficulty in patients who underwent gastrectomy for gastric cancer.

Methods

We retrospectively reviewed surgical outcomes in 516 consecutive patients who underwent gastrectomy for gastric cancer.

Results

The readmission rate within one year was 13.8%. Readmission due to nutritional difficulty was observed in 20 patients (3.9%), and nutritional difficulty was the second leading cause of readmission. Multivariate analysis revealed that the type of gastrectomy and the modified frailty index were independent predictive indicators of readmission due to nutritional difficulty. The readmission rates due to nutritional difficulty were 1.2%, 4.7%, and 11.5% in patients who underwent distal partial gastrectomy and had low modified frailty index, in those who underwent distal partial gastrectomy and had high modified frailty index or those who underwent either proximal partial or total gastrectomy and had low modified frailty index, and in those who underwent either proximal partial or total gastrectomy and had high modified frailty index, respectively ($P = 0.0008$).

Conclusions

Because the readmission rate due to nutritional difficulty is high in patients who underwent either total or proximal partial gastrectomy with high modified frailty index, intensive follow-up and nutritional support is needed to reduce readmission due to nutritional difficulty, which can help improve the patients' quality of life and reduce additional medical costs.

Background

Readmission to hospital is associated with increased medical costs. Stephen et al. demonstrated that 19.6% of the patients were rehospitalized within 30 days in the Medicare patient population[1]. This study estimated that the excess healthcare costs to Medicare from unplanned readmissions were USD 17.4 billion. In such a background, the Affordable Care Act mandated the establishment of the Hospital Readmissions Reduction Program, which penalized payments to hospitals with excess readmissions. In

addition to increased medical costs, readmission worsens a patient s' quality of life. Readmission often forces patients to be hospitalized for long periods, which prevents them from returning to their regular lives. Furthermore, a recent study demonstrated that readmission was significantly associated with poor prognosis in patients[2, 3]. Therefore, it is extremely important to avoid readmission of patients who have undergone surgery. To this end, it is important to develop reliable indicators that predict readmission after operation.

Gastric cancer (GC) is one of the most common malignancies worldwide[4]. The mainstay of curative treatment in GC is gastrectomy with regional lymph node dissection. Because gastrectomy is frequently associated with poor food intake due to decreased stomach volume, some patients experience readmission due to nutritional difficulty after discharge from hospital. A meta-analysis demonstrated that the incidence of 30-day readmission after radical gastrectomy was 8% (range, 4–12%)[5]. The main causes for 30-day readmission were nutritional difficulty and surgical site infections. Although the causes of readmission varied among patients who underwent gastrectomy for GC, nutritional difficulty was again one of the main causes of readmission in these patients. Recent studies have demonstrated that planned nutritional support could improve the nutritional status of patients who underwent gastrectomy for GC[6, 7]. Therefore, it might be possible to avoid readmission due to nutritional difficulty by intensive nutritional support in these patients. The development of predictive indicators for readmission due to nutritional difficulty enables the selection of patients who are at high risk of readmission due to nutritional difficulty after operation. However, such indicators remain unclear in GC patients so far. The current study aimed to identify predictive indicators for readmission due to nutritional difficulty in patients who underwent gastrectomy for GC.

Methods

Patients

Five hundred and sixteen consecutive patients with a pathological diagnosis of gastric adenocarcinoma who underwent gastrectomy at Tottori University Hospital between January 2010 and December 2017 were enrolled in this study. Patients with gastric-tube cancer and synchronous primary cancer were excluded from this study. These patients underwent distal partial gastrectomy (DG), total gastrectomy (TG), or proximal partial gastrectomy (PG) with dissection of the regional lymph nodes. Patient information was obtained retrospectively through a review of the hospital's database. The institutional review board of Tottori University Hospital approved the study (approval number: 17A152) and the requirement for informed consent was waived for this retrospective study. Clinicopathologic findings were based on the 15th edition of the Japanese Classification of Gastric Carcinoma[8].

In this study, readmission was defined as hospitalization after primary discharge due to unexpectable causes associated with GC or surgery and treatment for GC. Although admission after primary discharge for planned chemotherapy was not considered to be readmission in this study, admission due to adverse events associated with chemotherapy was considered as such. We focused on readmission within one

year in this study because the condition of patients who undergo gastrectomy for GC is generally unstable for one year after surgery. In this regard, Kim et al. had reported that approximately 80% of readmissions were observed within one year after surgery in GC patients who underwent gastrectomy[9]. When patients had multiple causes for readmission, the most significant one was recorded as the cause of readmission.

Modified Frailty Index (mFI)

mFI is based on the accumulation of 11 physiological deficits, derived from the original 70-item Canadian Study of Health and Aging Frailty Index[10]. Patients were assigned 1 point for each of the 11 physiological deficits, and the total points assigned to each patient were divided by 11. On this scale, a higher score implied increased frailty[11].

Prognostic nutritional index (PNI)

The serum albumin concentration and total lymphocyte count of the peripheral blood were measured in the month before surgery. PNI was calculated using the formula: 10 × serum albumin level + 0.005 × total peripheral lymphocyte count[12].

Statistical analysis

Continuous variables were expressed as mean ± standard deviation. Differences in the interval between primary discharge and first readmission, and in the number of times of readmission between patients who experienced readmission due to nutritional difficulty and those who experienced readmission due to other causes were determined using the Mann-Whitney U-test. Differences between the categorized variables were determined using the Chi-squared test. The Youden index was calculated using receiver operating characteristic (ROC) analysis to determine optimal cutoffs for continuous variables (age, body mass index, PNI, and mFI) in analysis of readmission. Univariate and multivariate analyses were performed to identify predictive indicators for readmission using logistic regression analysis. The stepwise procedure was used to identify possible predictive factors for readmission in multivariate analysis. $P < 0.05$ was considered statistically significant. GraphPad Prismversion 6 (GraphPad Software, Inc., La Jolla, CA, USA) and SPSS Statistics, version 24 (IBM Corp., Armonk, NY) were used for the statistical analyses.

Results

Table 1 shows the clinical features of the patients included in this study. Among 516 patients, 94 one-year readmissions were observed in 71 patients (13.8%): once in 56 patients (78.9%), twice in 10 patients (14.1%), three times in 3 patients (4.2%), four times in one patient (1.4%), and five times in one patient (1.4%). Table 2 shows the causes of these 94 one-year readmissions. The leading cause of readmission was palliative care (n = 30), followed by nutritional difficulty (n = 25), ileus (n = 13), and adverse events of chemotherapy (n = 11). Nutritional difficulty associated with chemotherapy was considered to be an adverse event of chemotherapy in this study. With regard to readmission for nutritional difficulty, 31 one-

year readmissions were observed in 20 patients (3.9%): once in 14 patients, twice in 4 patients, four times in one patient, and five times in one patient. Figure 1 shows the interval between primary discharge and first readmission. The 7-day, 30-day, and 90-day readmission rates were 8.5% (6/71), 26.8% (19/71), and 52.1% (37/71), respectively, across all cases. The 7-day, 30-day, and 90-day readmission rates for nutritional difficulty were 20% (4/20), 50% (10/20), and 75% (15/20), respectively. The interval between primary discharge and first readmission due to nutritional difficulty was significantly shorter than that due to other causes of readmissions (68.4 ± 88.1 vs. 136.4 ± 101.0; P = 0.002). On the other hand, there was no significant difference in the number of times of readmission between patients who experienced readmission due to nutritional difficulty and those who experienced readmission due to other causes (1.6 ± 1.1 vs. 1.2 ± 0.6; P = 0.25).

Because most readmissions due to nutritional difficulty were observed within one year, we determined the predictive factors of readmission within one year as well. Univariate analysis of clinicopathologic characteristics to identify the predictive factors for one-year readmission due to nutritional difficulty revealed that age, the type of gastrectomy, mFI, and PNI were predictive indicators of readmission due to nutritional difficulty (Table 3). We then included those parameters significant at $P < 0.05$ in the univariate analysis in the multivariate analysis. Multivariate analysis and stepwise procedure revealed that mFI and the type of gastrectomy were independent predictive indicators of readmission due to nutritional difficulty (Table 3). Figure 2 shows the correlation between the number of independent predictive indicators and the frequency of readmission due to nutritional difficulty. The readmission rates due to nutritional difficulty were 1.2%, 4.7%, and 11.5% in patients who underwent DG and had low mFI, in those who either underwent DG and had high mFI, or underwent either PG or TG and had low mFI, and in those who underwent either PG or TG and had high mFI, respectively, indicating that the number of independent predictive indicators (the type of gastrectomy and mFI) was significantly associated with readmission due to nutritional difficulty ($P = 0.0008$). Furthermore, ROC analysis indicated that the area under curve (AUC) of the number of independent predictive indicators was much higher than that of either mFI or the type of gastrectomy alone (Fig. 3).

Discussion

In this study, we first demonstrated that 13.8% of patients who underwent gastrectomy for GC experienced readmission within one year. Choe et al. reported that 11.7% of patients were readmitted within one year after gastrectomy[13]. Kim et al. reported that the 5 year-readmission rate was 13.0% in patients who underwent radical subtotal gastrectomy for early GC[9]. They also reported that approximately 80% of patients were readmitted within one year, indicating that the one-year readmission rate was approximately 10%. The one-year readmission rate in this study was slightly higher than their results, which might be due to the inclusion of advanced GC in our study and the difference in health insurance systems.

Because gastrectomy reduces the volume of the stomach, many patients who have undergone gastrectomy for GC experience nutritional difficulty due to insufficient food intake after surgery. Food

intake gradually increases in most patients as the number of postoperative days increases. However, food intake sometimes decreases again in some patients after they leave the hospital because it is often difficult to prepare suitable food at home for post-gastrectomy patients. Such patients are likely to be rehospitalized for nutritional support. Patients who undergo gastrectomy for GC are expected to be at high risk of readmission due to poor food intake when compared with patients who undergo surgeries other than gastrectomy. In fact, nutritional difficulty after gastrectomy was the second leading cause of readmission in patients who underwent gastrectomy for GC in this study. This study revealed that the interval from primary discharge to first readmission due to nutritional difficulty was significantly shorter than that due to other causes. In fact, 50% of patients with readmission within one year experienced 30-day readmission in this study. Therefore, the short interval from primary discharge to first readmission was the unique characteristic of readmission due to nutritional difficulty compared with readmission due to other causes.

It is important to note that readmission due to nutritional difficulty could be avoidable. Baker et al. have suggested that home enteral nutrition for 6 weeks through a feeding jejunostomy tube did not affect oral intake of a regular diet and improved postoperative nutrition following TG[6]. Recently, oral nutritional supplements (ONS) have been of great interest as perioperative nutritional interventions in patients with GC who underwent gastrectomy. Kimura et al. demonstrated that administration of 300 kcal/day of ONS for 6 to 8 weeks in the early post-gastrectomy period reduced body weight loss not only at 6 to 8 weeks postoperatively but also at 1 year in patients who underwent TG[7]. Therefore, nutritional support might be useful in preventing readmission due to nutritional difficulty. However, it is not practical to provide intensive nutritional support for all patients who undergo gastrectomy for GC. Therefore, it is indispensable to predict patients who are at high risk of readmission due to nutritional difficulty and provide intensive nutritional support for those patients. In this study, we identified that the type of gastrectomy and the mFI were independent predictive indicators for readmission due to nutritional difficulty. With regard to the type of gastrectomy, total gastrectomy and proximal gastrectomy were risk factors for readmission due to nutritional difficulty. According to the Post Gastrectomy Syndrome Assessment Study, one-year body weight reduction rates after gastrectomy for GC were 13.8 %, 10.9 %, 7.9 % and 8.9 % in TG, PG, DG with Billroth-I reconstruction, and DG with Roux-en-Y reconstruction, respectively, indicating that higher body weight reduction rates were observed more frequently in patients with ether TG or PG than in those with DG[14, 15]. Therefore, patients who underwent ether TG or PG are more likely to have nutritional difficulty after surgery than those who undergo DG. Furukawa et al. recently reported that subtotal gastrectomy with a very small remnant stomach had more favorable short-term outcomes and nutritional status than total and proximal gastrectomy[16]. Even though the remnant stomach is very small, it seems to be useful in maintaining ghrelin secretion and reducing gastro-esophageal reflux through preservation of the gastric cardia, which contributes to a favorable postoperative nutritional status. Therefore, it might be possible to reduce readmission due to nutritional difficulty through the improvement of surgery.

Frailty is a syndrome characterized by decreased physiological reserve. It has been reported to be associated with an increased risk of adverse outcomes in patients who undergo surgery[17–20]. A

standardized, quantifiable assessment of frailty may enable surgeons to evaluate patients' risk of adverse outcomes after surgery. Therefore, the development of a useful and less complex tool to evaluate frailty is indispensable to improve patient outcomes. The modified frailty index (mFI) is one such tool based on the assessment of 11 physiological deficits collected by the American College of Surgeons National Surgical Quality Improvement Program (NSQIP)[11]. These 11 items are easily identifiable during patient encounters and are defined as the proportion of potential deficits that are present in an individual to the 11 potential deficits that were evaluated. The mFI has been found to be predictive for postoperative short-term outcomes in several surgical populations, including patients undergoing abdominal, vascular, and head and neck surgery[21–24]. However, the correlation between mFI and readmission due to nutritional difficulty has not been well determined so far. In this regard, Choe et al. reported that preoperative assessment of frailty could predict readmission within one year of discharge after gastrectomy[13]. In their study, frailty was assessed using the Study of Osteoporotic Fractures frailty index. Furthermore, all causes associated with one-year readmission were included in their study. On the other hand, we used mFI to evaluate frailty and found a close correlation between mFI and one-year readmission due to nutritional difficulty. Our study clearly demonstrated that frail GC patients were at high risk of readmission due to nutritional difficulty. This indicates the possibility that frail GC patients find it more difficult to adjust to the post-gastrectomy status than non-frail GC patients. To the best of our knowledge, this is the first study to demonstrate the close correlation between mFI and one-year readmission due to nutritional difficulty.

Our study demonstrated that the combination of mFI and the type of gastrectomy was more useful in predicting readmission due to nutritional difficulty than single use of those indicators. Because readmission rate due to nutritional difficulty was high in patients who underwent either TG or PG with high mFI, intensive follow-up and nutritional support should be performed in such patients to reduce readmission due to nutritional difficulty.

The present study had some limitations. First, its retrospective design was associated with some bias. Second, only a small number of patients were included, and a larger trial is required to confirm our results. Third, all patients included in this study were Japanese. Because insurance systems are different for each country, the indications for readmission might also be different for each country; this is likely to affect the predictive factors for readmission.

In conclusion, we demonstrated that the type of gastrectomy and the mFI were predictive indicators for readmission due to nutritional difficulty in patients who underwent gastrectomy for GC. Because the readmission rate due to nutritional difficulty was high in patients who underwent either TG or PG with a high mFI, intensive follow-up and nutritional support should be provided in such patients to reduce readmission due to nutritional difficulty, to improve patients' QOL and prognosis, and to reduce additional medical costs.

Abbreviations

AUC
area under curve; DG:distal partial gastrectomy; GC:gastric cancer; mFI:modified frailty index; NSQIP:national surgical quality improvement program; ONS:oral nutritional supplements; PG:proximal partial gastrectomy; PNI:prognostic nutritional index; ROC:receiver operating characteristic; TG:total gastrectomy; USD:United States dollar

Declarations

Ethics approval and consent to participate: All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1964 and later versions. This study was approved by Certified Review Board, Tottori University Hospital, and the requirement for informed consent was waived.

Consent for publication: Not applicable.

Availability of data and materials: The datasets generated during and analysed during the current study are not publicly available due to their containing information that could compromise the privacy of research participants but are available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests.

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Authors' contributions: TO and HS participated in the design of the study, interpretation of data, analysis, and drafting the article. WM, YS, KM, TM, and ST collected data. YF revised the article. All authors approved the final version of the article.

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Tables

Due to technical limitations, table 1,2,3 is only available as a download in the Supplemental Files section.

Figures

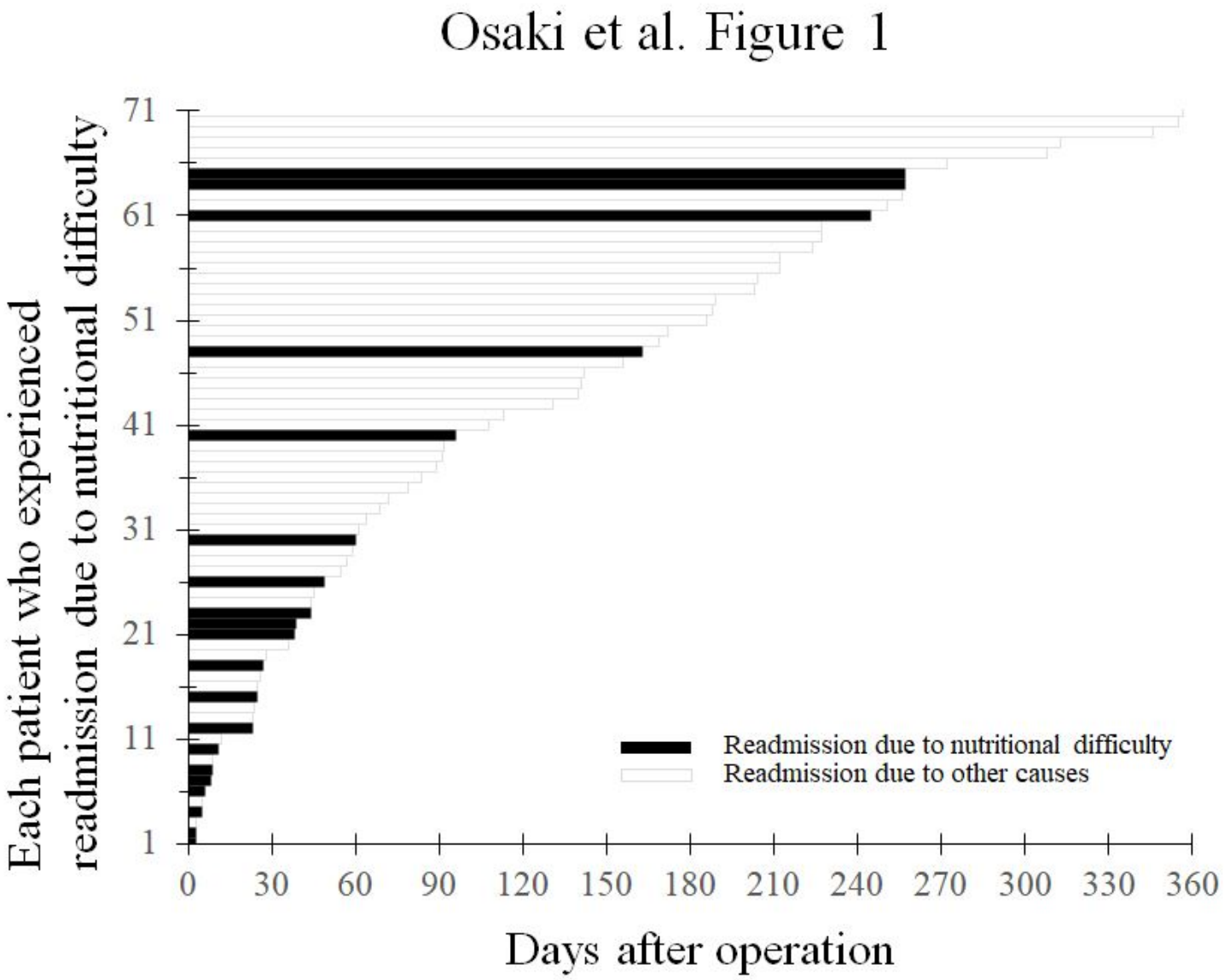

Figure 1

The interval from primary discharge to first readmission in patients who underwent gastrectomy for gastric cancer.

Osaki et al. Figure 2

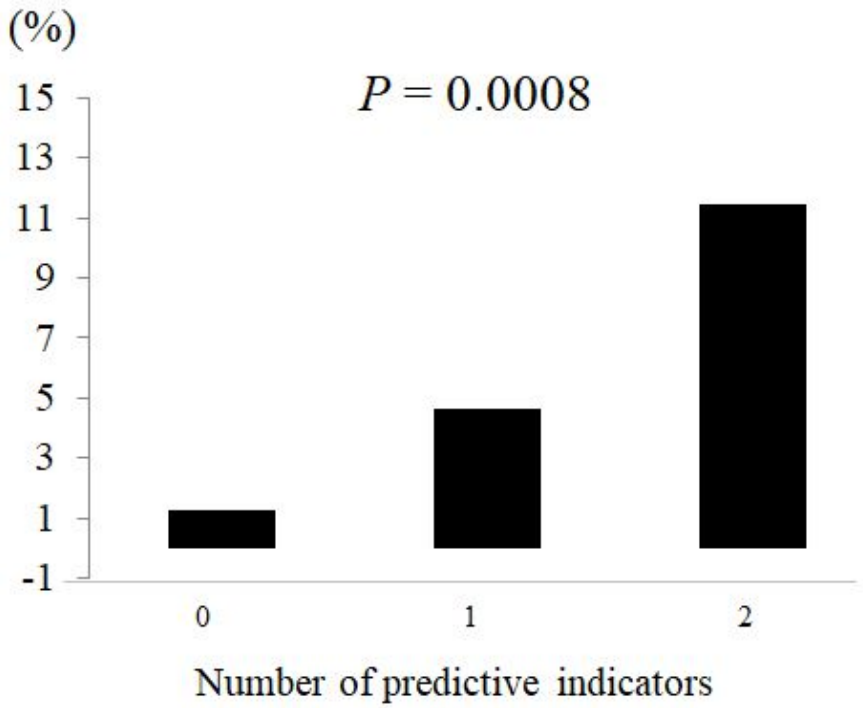

Figure 2

The readmission rates due to nutritional difficulty, according to the type of gastrectomy and mFI.

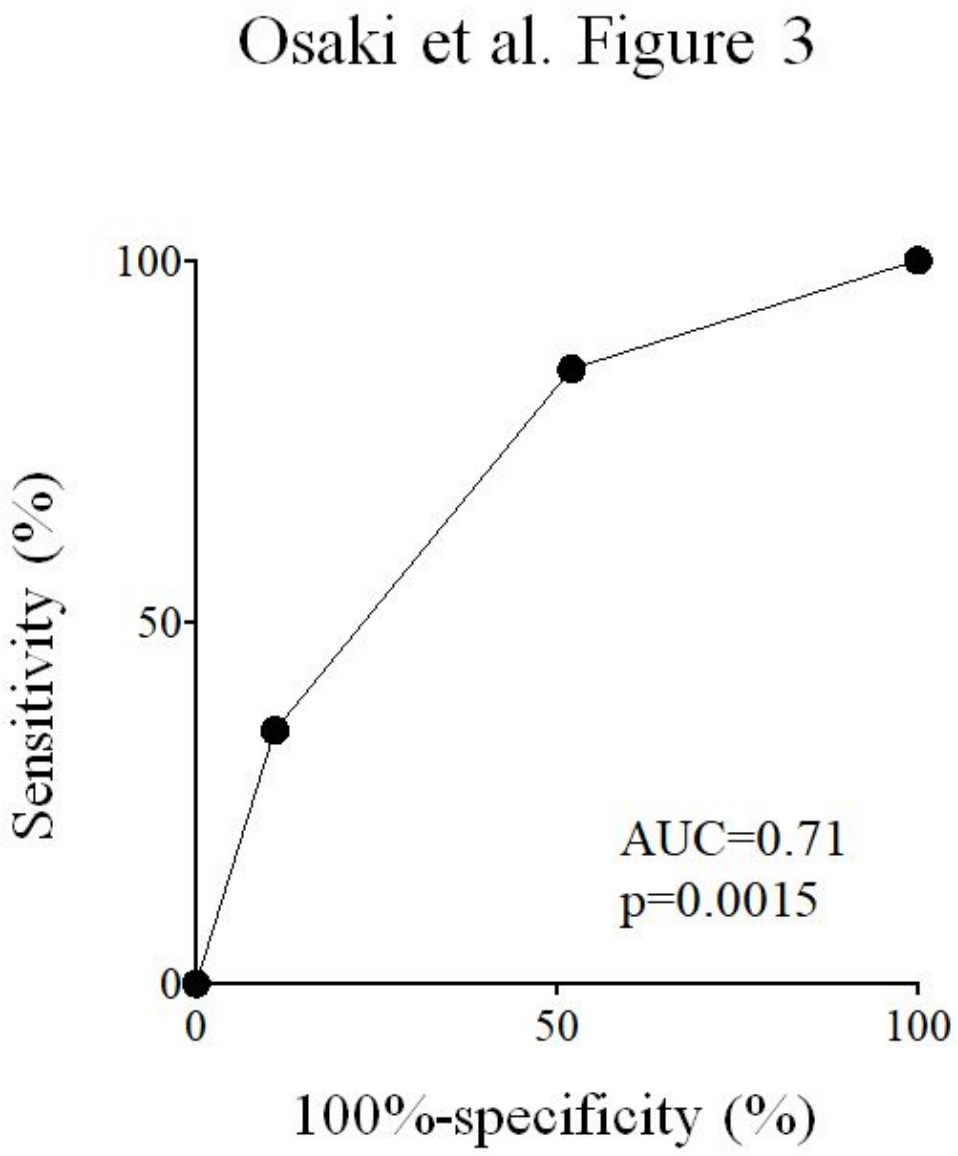

Figure 3

ROC curve combining the type of gastrectomy and the mFI for readmission due to nutritional difficulty.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Table1.jpg
- Table1a.jpg
- Table2.jpg
- Table3.jpg