The impact of neoadjuvant systemic therapy on the surgical management of soft tissue sarcoma

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Chapter 7

Improvement of perioperative outcomes of gastric gastrointestinal stromal tumour resections and the influence of minimal invasive surgery

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Abstract

Background
Safety of minimally invasive surgery (MIS) for gastrointestinal stromal tumours (GISTs) is still under debate since it might increase the risk of tumour rupture, especially in larger tumours. The aim of this study was to investigate trends in treatment and perioperative outcomes of patients undergoing resections of gastric GISTs over time.

Methods
This was a multicentre retrospective study of consecutive patients who underwent wedge resection or partial gastrectomy for localized gastric GIST at five GIST reference centres between January 2009 and January 2022. To evaluate changes in treatment and perioperative outcomes over time, patients were divided into four equal periods. Perioperative outcomes were analysed separately and as a novel composite measure textbook outcome (TO).

Results
In total 385 patients were included. Patient and tumour characteristics did not change over time, except for median age (62-65-68-68 years, p= 0.002). The proportion of MIS increased (4.0%-9.8%-37.4%-53.0%, p< 0.001). Postoperative complications (Clavien Dindo ≥2; 22%-15%-11%-10%, p= 0.146), duration of admission (6-6-5-4 days, p<0.001) and operating time (92-94-77-73 min, p= 0.007) decreased over time while TO increased (54.0%- 52.7%-65.9%-76.0%, p< 0.001). No change was seen in perioperative ruptures (6.0%- 3.6%-1.6%-3.0%, p= 0.499). MIS was correlated with less CD ≥2 complications (p= 0.006), shorter duration of admission (p<0.001) and more TO (p<0.001). Similar results were observed in tumours ≤5 cm and >5 cm.

Conclusion
A larger percentage of gastric GIST were treated with MIS over time. MIS was correlated with less complications, shorter duration of admission and more TO. Tumour rupture rates remained low over time.

Introduction

Gastrointestinal stromal tumours (GISTs) are the most common mesenchymal tumours originating in the gastrointestinal tract. The incidence is 1-1.5 / 100.000 per year and they predominantly manifest in the stomach (50-60%) (1-3). According to the ESMO guidelines (4), complete surgical excision is the standard of care treatment for patients with local unifocal GISTs. Since surgical treatment is the mainstay of therapy, continuous effort should be put in measuring and improving its quality.

In 2009, the Dutch GIST Registry (DGR) was initiated by the Dutch GIST consortium (DGC) comprising the five GIST reference centres. The DGR is a prospective database including all patients with a GIST in the Netherlands that had (part of) their treatment in one of these expert centres. In the DGR, the patient, tumour and treatment characteristics together with oncologic outcomes are collected. Also, common parameters for perioperative outcomes like mortality, morbidity and complication rates are captured prospectively (5, 6).

Since the start of the DGR, there has been increasing support for minimally invasive surgery (MIS) for surgical excision of GIST. MIS is defined as a laparoscopic or robotic surgical approach. Yet today, MIS is only suggested as standard care in patients with smaller GIST (≤ 5 cm) in most national guidelines, including The Netherlands (7). A laparoscopic approach is strongly discouraged for patients with large tumours due to the risk of tumour rupture, which is significantly linked to a very high risk of relapse. (4, 8, 9) Nonetheless, recent literature showed that even in larger tumours (> 5 cm) treated with MIS similar overall survival and oncological outcomes were found compared with open surgery (10-12).

In this study, the use of MIS in patients with gastric GISTs in the past 13 years is evaluated. The primary aim of the study was to evaluate the perioperative outcomes after gastric GIST resections over time and assess the influence of MIS. As secondary aim, textbook outcome (TO) was introduced as a composite outcome measure to evaluate perioperative outcomes (13-17).

Methods

Patient selection
All patients who are treated or discussed on a multidisciplinary tumour board meeting (MTB) for consultation in one of five GIST reference centres are registered in the DGR since 2009. The GIST reference centres are the Netherlands Cancer Institute-Antoni van Leeuwenhoek Hospital (NKI-AVL), Erasmus Medical Centre (EMC), Radboud University Medical Centre (Radboudumc), Leiden University Medical

Centre (LUMC), and University Medical Centre Groningen (UMCG). For this study, patients who underwent a wedge resection or a partial gastrectomy of a unifocal localised gastric GIST between January 2009 and January 2022 in a reference centre were eligible.

Data collection

Data was collected with approval of the institutional review boards (IRBd20-212). Available patient characteristics, tumour characteristics, and perioperative outcomes were retrieved from the DGR. For this study, the main perioperative outcomes involved tumour rupture, surgical margin, reoperation, readmission, complications (Clavien Dindo ≥2), duration of admission and operating time. Tumour rupture was defined as the microscopic disruption of serosa, as described by the pathologist, tumour spillage, or gastrointestinal perforation at the tumour site within the abdominal cavity. Body mass index (BMI), American Society of Anaesthesiologists (ASA) classification (18), size of the tumour after neoadjuvant imatinib, reoperation, readmission, operating time and duration of admission were not included in the DGR and were added retrospectively. A resection was defined as R0 when no tumour was seen at the inked surface, and as R1 or R2 when microscopic or macroscopic residual tumour was detected, respectively.

Textbook outcome

TO was created as a new composite outcome measure for gastric GIST based on already existing TO for gastric cancer (8, 10, 41). In this study, TO was defined as R0 resection, no perioperative tumour rupture, no surgical complications with Clavien Dindo ≥2, no surgery or readmission within 90 days after resection, and no prolonged duration of admission. Prolonged admission was defined as being part of the 25% of the patients with the longest duration of admission.

Study design

In order to compare perioperative outcomes over time, all patients were grouped into four equal time periods of 40.5 months. Period I extended from 06-01-2009 to 15-05-2012, period II from 16-05-2012 to 30-09-2015, period III from 01-10-2015 to 14-02-2019, and period IV from 15-02-2019 to 17-01-2022. Differences over time in patient characteristics, treatment characteristics, and perioperative outcomes were analysed. The influence of MIS on all separate perioperative outcomes was evaluated with a multivariate regression analysis. For this analysis of all perioperative outcomes, the use of MIS, BMI, tumour size and the use of neoadjuvant imatinib were included. Age and ASA score were included in the analysis as well for complications, readmission, reoperation surgery time, duration of admission, and TO. A sub-analysis was done to demonstrate the difference in perioperative outcomes between larger and smaller tumours. All patients were divided based on

tumours ≤5 cm and >5 cm. Within those two groups, open surgery was compared with MIS.

Statistical analysis

To describe non-normally distributed data, median and interquartile range (IQR) were used. To compare ordinal data, the chi square test was used and to compare non-normally distributed data the Kruskal–Wallis test was used. Univariable regression analyses were performed to investigate the effect of time of resection (period), age, MIS, BMI, ASA score, tumour size before surgery and treatment with neoadjuvant imatinib on each perioperative outcome separately. Variables with p-values <0.2 in the univariable analyses were combined in a multivariable regression analysis. The type of regression analysis for every perioperative outcome, was based on data being ordinal or continuous. For ordinal perioperative outcomes, a binary regression analysis was performed. For continuous data with a gamma distribution, a generalized linear model was used with log link for regression analysis. SPSS version 27 was used to analyse the data. A p-value <0.05 was considered to indicate statistical significance.

Results

Patient population

Of 385 patients included in this study, 50 (13.0%), 112 (29.1%), 123 (31.9%), and 100 (26.0%) patients were operated on in period I, II, III, and IV, respectively. Patient selection is displayed in Figure 1. Baseline and treatment characteristics are shown in Table 1. The proportion of patients who underwent MIS increased over time (4.0% vs. 9.8% vs. 37.4% vs. 53.0%, p < 0.001). Median age at time of surgery increased (62 vs. 65 vs. 68 vs. 68 years, p = 0.002). Other variables did not change over time.

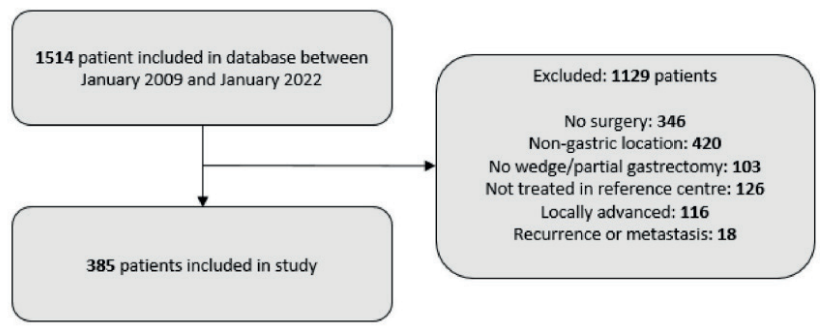

Figure 1. A flow chart demonstrating patient selection

Table 1. Baseline and treatment characteristics.

	Period I N= 50		Period II N= 112		Period III N= 123		Period IV N= 100		*p*
Man	30	(60.0)	49	(43.8)	57	(46.3)	58	(58.0)	0.074
Age (i.q.r.)	64	(56 - 70)	65	(57 - 72)	68	(59 - 76)	67	(58 - 74)	**0.037**
BMI (i.q.r.)	28	(25 - 31)	26	(24 - 29)	27	(24 - 30)	27	(24 - 29)	0.571
ASA									
1	11	(22.0)	34	(30.4)	18	14.6)	19	(19.0)	0.051
2	21	(42.0)	56	(50.0)	82	(66.7)	55	(55.0)	
3	4	(8)	15	(13.4)	13	(10.6)	21	(21.0)	
4	0	(0.0)	1	(0.9)	1	(0.8)	0	(0.0)	
Missing	14	(28.0)	6	(5.4)	9	(7.3)	5	(5.0)	
Open or MIS									
Open	48	(96.0)	101	(80.2)	77	(62.6)	47	(47.0)	**<0.001**
MIS	2	(4.0)	11	(9.8)	46	(37.4)	53	(53.0)	
Tumour size in mm (i.q.r.)	56	(37 - 80)	55	(40 - 75)	49	(33 - 73)	52	(35-76)	0.156
Tumour size									
≤50mm	22	(44.0)	52	(46.4)	64	(52.0)	49	(49.0)	0.748
>50mm	28	(56.0)	60	(53.6)	59	(48.0)	51	(51.0)	
Neo adjuvant imatinib									
Yes	14	(28.0)	44	(39.3)	37	(30.4)	33	(33.0)	0.389
No	36	(72.0)	68	(60.7)	86	(69.9)	67	(67.0)	
Surgery setting									
Planned	50	(100)	108	(96.4)	116	(94.3)	99	(99.0)	0.118
Emergency	0	(0.0)	4	(3.6)	7	(5.7)	1	(1.0)	
Location in stomach									
Cardia	3	(6.0)	10	(8.9)	10	(8.1)	1	(1.0)	0.289
Fundus	10	(20.0)	20	(17.9)	21	(17.1)	19	(19.0)	
Greater curvature	14	(28.0)	27	(24.1)	29	(23.6)	32	(32.0)	
Smaller curvature	16	(32.0)	38	(33.9)	38	(23.6)	27	(27.0)	
Antrum	3	(6.0)	11	(9.8)	14	(11.4)	13	(13.0)	
Missing	4	(8.0)	6	(5.4)	11	(8.9)	8	(8.0)	

Values are n (%) unless otherwise indicated period I extended from 06-01-2009 to 15-05-2012, period II from 16-05-2012 to 30-09-2015, period III from 01-10-2015 to 14-02-2019, and period IV from 15-02-2019 to 17-01-2022. Abbreviations: BMI = body mass index, MIS = minimal invasive surgery, mm = millimeter

Perioperative outcomes

Duration of admission (6 vs. 6 vs. 5 vs. 4 days, p<0.001) and operating time (92 vs. 94 vs. 77 vs. 73 min, p=0.007) decreased significantly. A non-significant decreasing trend was seen for complications CD ≥2 (22% vs. 15% vs. 11. vs 10%, p = 0.146). The proportion of patients with a TO increased (54.0% vs. 52.7% vs. 65.9% vs 76.0%, p < 0.001; Figure 2). Of all patients, 3.1% had a perioperative rupture, 6.2% had a R1/2 resection, 2.6% a reoperation, and 3.6% a readmission. These outcomes were stable and did not show any trends over time (Table 2). Conversion was necessary in 15.2% (n= 17) of all laparoscopic operations. No trend over time was observed (p= 0.547).

Table 2. Perioperative outcomes per time period

	Period I N= 50		Period II N= 112		Period III N= 123		Period IV N= 100		*p*
Irradical resections	4	(8.0)	8	(7.1)	6	(4.9)	6	(6.0)	0.840
Missing	0	(0.0)	1	(0.9)	0	(0.0)	0	(0.0)	
Peroperative tumour ruptures	3	(6.0)	4	(3.6)	2	(1.6)	3	(3.0)	0.499
Missing	0	(0.0)	2	(1.8)	0	(0.0)	0	(0.0)	
Postoperative complications	11	(22.0)	17	(15.2)	14	(11.4)	10	(10.0)	0.146
Missing	2	(4.0)	1	(0.9)	1	(0.8)	0	(0.0)	
Reoperations	1	(2.0)	2	(1.8)	4	(3.3)	3	(3.0)	0.891
Missing	0	(0.0)	2	(1.8)	1	(0.8)	1	(1.0)	
Readmissions	3	(6.0)	3	(2.7)	4	(3.3)	4	(4.0)	0.769
Missing	0	(0.0)	2	(1.8)	1	(0.8)	1	(1.0)	
Duration of surgery (min) (i.q.r.)	92	(95 - 147)	94	(62 - 125)	77	(55 - 109)	73	(56 – 94)	**0.007**
Missing	3	(6.0)	7	(6.3)	16	(13.0)	16	(16.0)	
Duration of admission in days (i.q.r.)	6	(5 - 9)	6	(5 - 7)	5	(4 - 7)	4	(3 - 6)	**<0.001**
Missing	1	(2.0)	2	(1.8)	1	(0.8)	2	(2.0)	

Values are n (%) unless otherwise indicated. Period I extended from 06-01-2009 to 15-05-2012, period II from 16-05-2012 to 30-09-2015, period III from 01-10-2015 to 14-02-2019, and period IV from 15-02-2019 to 17-01-2022.

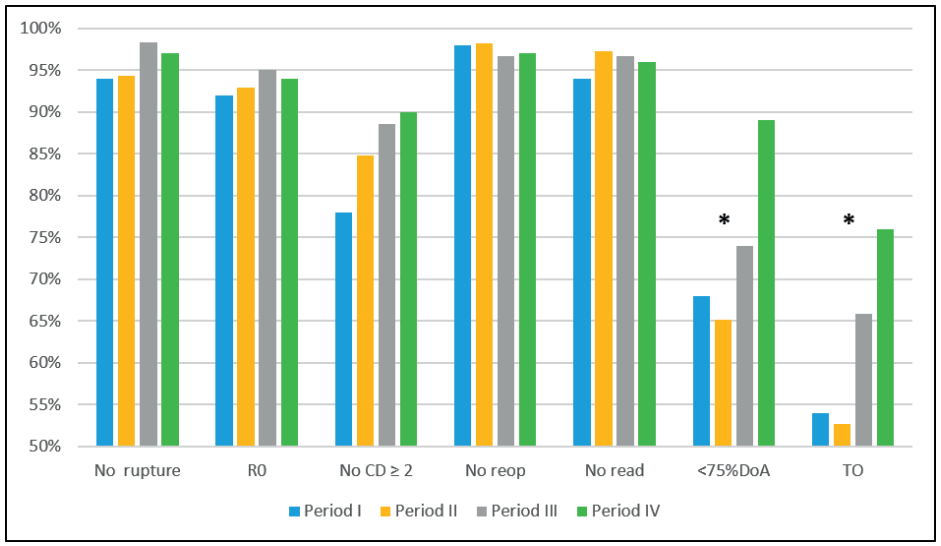

Figure 2. Perioperative outcomes and textbook outcome per period in patients treated in 5 Dutch GIST reference centres. * p <0.05 which is considered as a significant difference. RO = clear margins, CD = Clavien Dindo, reop = reoperation, read = readmission, DoA= duration of admission (hospital stay duration >6 days), TO = textbook outcome.

Multivariable regression analysis

The use of MIS was correlated with less CD ≥ 2 complications (p = 0.006), having a shorter duration of admission (p < 0.001) and with achieving more TO (p < 0.001). Larger tumours were correlated with more R1/2 resections (p < 0.001), more ruptures (p = 0.002), more reoperations (p < 0.001, based on univariate analysis due to insufficient events), and longer operating time (p < 0.001). Age correlated with more CD ≥ 2 complications (p = 0.004), longer duration of admission (p = 0.003), and a decreased proportion of TO (p = 0.002). Having ASA scores III&IV correlated with more reoperations (p = 0.004, based on univariate analysis due to insufficient events), longer durations of admission (p= 0.019), and less TO (p = 0.015). A higher BMI was correlated with longer duration of surgery (p = 0.043). Odds ratios and regression coefficients are displayed in Table 3 and supplementary Table 1.

Open surgery vs. MIS for tumours ≤5 cm and >5 cm

No significant differences were seen in age, BMI, ASA score, and location of the tumour in the stomach between patient who underwent open surgery or MIS (Table 4). Patients treated with open surgery had larger tumours (p <0.001) and more neoadjuvant imatinib use (p <0.001) compared with patients treated with MIS. Patients were divided based on tumour sizes ≤5 cm and >5 cm to compare perioperative outcomes within those subgroups (Table 5). For patients with tumours ≤5 cm, MIS resulted in significantly less complications (p = 0.005) and shorter duration of admission (p < 0.001). For patients with tumours >5 cm, MIS resulted also in significantly shorter duration of admission. For both tumour sizes, no significant differences in R0 resections or tumour ruptures were seen between open surgery and MIS. MIS did result in significantly more TO for both groups (p = 0.006 and p = 0.004, respectively) (Figure 3).

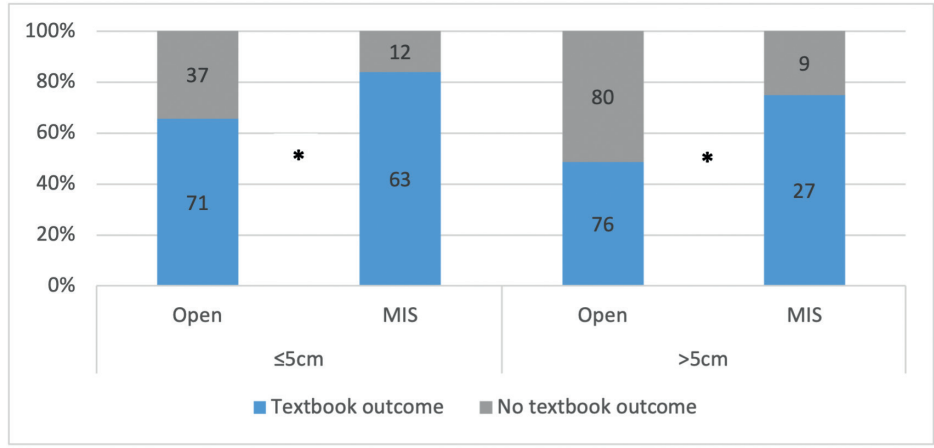

Figure 3. Textbook outcome by surgical approach and per tumour size ≤5 cm and >5 cm MIS = minimal invasive surgery. * p <0.05 which is considered as a significant difference

Table 3. Univariable and multivariable regression analysis for perioperative surgical outcomes in patients treated in GIST reference centres. Per perioperative outcome, only factors with p values < 0.2 after univariable regression are displayed in this table. See supplementary table 1 for all (including non significant) data *= these factors are regression coefficients and not odds ratios

	Univariable				Multivariable		
	N	OR	95% CI	*p*	OR	95% CI	*p*
R1/R2 resection	24						
Tumor size before surgery		1.013	1.006-1.020	**<0.001**			
Peroperative tumour ruptures	12						
Tumor size before surgery		1.013	1.005-1.021	**0.002**			
Postoperative complications	52						
Age		1.043	1.013-1.074	**0.005**	1.046	1.015-1.079	**0.004**
Minimal invasive surgery		0.278	0.115-0.672	**0.004**	0.280	0.113-0.694	**0.006**
ASA score III & IV		1.738	0.831-3.633	0.142	0.362	0.660-3.119	0.362
Tumor size before surgery		1.006	1.001-1.012	**0.032**	1.005	0.999-1.011	0.137
Reoperations	10						
ASA score III & IV		6.420	1.794-22.973	**0.004**			
Tumor size before surgery		1.016	1.008-1.024	**<0.001**			
Duration of surgery	343						
BMI		0.016*	0.004-0.027	**0.007**	0.012*	0.001 – 0.023	**0.043**
ASA score III & IV		0.113*	-0.0.52-0.278	0.178	0.097*	-0.066-0.260	0.245
Tumor size before surgery		0.003*	0.002-0.005	**<0.001**	0.003*	0.001 – 0.004	**0.001**
Neoadjuvant imatinib		0.135*	-0.254- -0.016	**0.026**	-0.056*	-0.183 – 0.070	0.381
≥75% duration of admission	106						
Age		1.031	1.010-1.053	**0.005**	1.036	1.012-1.060	**0.003**
Minimal invasive surgery		0.161	0.078-0.332	**<0.001**	0.164	0.077-0.351	**<0.001**
ASA score III & IV		2.272	1.253-4.122	**0.007**	2.202	1.140-4.253	**0.019**
Tumor size before surgery		1.008	1.003-1.013	**0.003**	1.004	0.999-1.010	0.153
Neoadjuvant imatinib		1.943	1.218-3.099	**0.005**	1.477	0.877-2.486	0.142
Textbook outcome	138						
Age		0.969	0.951-0.989	**0.002**	0.968	0.948-0.988	**0.002**
Minimal invasive surgery		3.411	2.001-5.815	**<0.001**	3.301	1.867-5.834	**<0.001**
ASA score III & IV		0.425	0.238-0.758	**0.004**	0.464	0.249-0.864	**0.015**
Tumor size before surgery		0.992	0.987-0.996	**<0.001**	0.995	0.990-1.001	0.167
Neoadjuvant imatinib		0.607	0.390-0.945	**0.027**	0.797	0.486-1.309	0.370

Table 4. Baseline and treatment characteristics per open surgery or minimally invasive surgery

	Open N = 273		MIS N= 112		*p*
Man	137	(50.2)	57	(50.9)	0.899
Age (i.q.r.)	65	(57 - 73)	68	(58 - 74)	0.181
BMI (i.q.r.)	27	(24 - 29)	26	(24 - 30)	0.739
ASA					
1	66	(24.2)	16	(14.3)	0.085
2	142	(52.0)	72	(64.3)	
3	36	(13.2)	17	(15.2)	
4	2	(0.7)	0	(0.0)	
Missing	27	(9.9)	7	(6.3)	
Tumour size in mm (i.q.r.)	55	(40 - 80)	43	(31 - 58)	**<0.001**
Tumour size					
≤50mm	112	(41.0)	75	(67.0)	**<0.001**
>50mm	161	(59.0)	37	(33.0)	
Neo adjuvant imatinib					
Yes	110	(59.7)	18	(83.9)	**<0.001**
No	163	(40.3)	94	(16.1)	
Surgery setting					
Planned	264	(100)	109	(96.4)	0.751
Emergency	9	(0.0)	3	(3.6)	
Location in stomach					
Cardia	19	(7.0)	5	(4.5)	0.289
Fundus	46	(16.8)	24	(21.4)	
Greater curvature	68	(24.9)	34	(30.4)	
Smaller curvature	93	(34.1)	26	(23.2)	
Antrum	27	(9.9)	14	(12.5)	
Missing	19	(7.0)	9	(8.0)	

Values are n (%) unless otherwise indicated Abbreviations: BMI = body mass index, MIS = minimal invasive surgery, mm = millimetre

Table 5. Differences between surgical approaches per tumour size ≤5 cm and >5

	< 5 cm			>5 cm		
	Open	MIS	p=	Open	MIS	p=
R0 resection						
Yes	109	71	0.349	144	36	0.154
No	3	4		16	1	
Rupture						
Yes	109	73	0.690	153	36	0.642
No	2	2		7	1	
Complications ≥2 CD						
Yes	95	74	**0.005**	129	31	0.406
No	14	1		32	5	
Reoperations						
Yes	109	75	0.242	152	35	0.657
No	2	0		6	2	
Readmissions						
Yes	105	75	0.661	154	36	0.953
No	6	3		4	1	
>75% DOA						
Yes	79	70	**<0.001**	94	33	**<0.001**
No	31	5		63	4	
Textbook outcome						
Yes	71	63	**0.006**	76	27	**0.004**
No	37	12		80	9	

Abbreviations: R0 = clear resection margins, CD = Clavien Dindo, DoA= duration of admission (hospital stay duration >6 days)

Discussion

The goal of this study was to evaluate the perioperative outcomes of resections of unifocal localised gastric (GIST) and to evaluate the role of minimally invasive surgery (MIS) in this context since the start of data collection for the Dutch Gist Registry (DGR) 13 years ago. The perioperative outcomes improved over time in terms of less complications and shorter duration of admission and operating time while the use of minimally invasive surgery (MIS) increased. Based on the current data, MIS was correlated with less complications and a shorter duration of admission. MIS was not correlated with more R1/2 resections or more perioperative tumour ruptures, neither in tumours >5 cm. As a secondary aim, textbook outcome (TO) was defined as a new composite measure. Analyses of TO displayed an increase over time and more TO after MIS compared with open surgery.

An increased use of MIS from 4% to 53% resulting in less complications and shorter duration of admission is in line with previous reports. In the US, there was an increase from 26% to 49% between 2010 and 2016 (12), and in China MIS rates in patients with GISTs increased from 24% (2005-2010) to 51% (2010-2017),

respectively (19). Numerous studies confirmed a favourable effect of MIS on the duration of admission and complication rate compared with open surgery (20-30). This outcome can be attributed to the shorter recovery period after MIS because of smaller incisions. In addition, shorter time of admission results in less costs, which is another favourable outcome of MIS.

According to the European Society for Medical Oncology (ESMO) guidelines, the primary objective of a GIST resection is to achieve tumour free margins (4). Based on previous literature, there was no difference in achieved R0 resections between MIS and open surgery (19-22, 25, 31-33). The same was true in this study, as it did not adversely affect the likelihood of R1/R2 resections or tumour rupture. This was the case for tumours ≤5 cm and >5 cm, which is in line with other studies (10-12). Both outcomes are prognostic factors for OS, although rupture is more important (34, 35). Since MIS does not influence both outcomes in our data, it attributes to the existing literature stating that the use of MIS for gastric GIST does not negatively influence oncological outcomes (11, 36, 37). More MIS for gastric GIST resections can be regarded as a positive development based on this data.

Contrary to the utilization of MIS, larger tumour size was found to be correlated with longer operating time, higher risk of R1/2 resections, and tumour ruptures, which is in line with previously reported studies (4, 38, 39). Because of these negative effects of larger tumours on surgical outcomes, the use of neoadjuvant imatinib should be considered. Large randomized controlled trials on the effect of neoadjuvant treatment are lacking, but numerous retrospective studies show that neoadjuvant imatinib results in a decrease in size if imatinib sensitive mutations are present (40-45). In order to mitigate the risk of tumour ruptures, we suggest that larger GIST should be discussed at dedicated multidisciplinary tumour boards to determine the suitability of neoadjuvant imatinib.

Two factors negatively affecting the surgical outcomes were age and ASA score. Higher age is correlated with more complications, longer duration of admission and a smaller likelihood of TO. Studies on age and complications in patients who underwent gastric surgery all showed similar results to the data in this study, with a correlation between higher age and more complications (46-48). More complications understandably result in longer duration of admission, but age itself is also a risk factor according to the American college of Surgeons (49). A higher ASA score was correlated with longer duration of admission and less TO. An explanation for these correlations might be that patients with impaired fitness generally have impaired perioperative outcomes (50).

TO was included in this study because there is an increasing field of interest in quality assessment after oncologic surgery (51). With the introduction of TO, it was

made easier to compare the surgical outcomes between hospitals and between time periods. As shown in this study, trends in perioperative outcomes over time, can be demonstrated or quality differences between hospitals can be assessed. For patients with GISTs, no universally accepted definition for a textbook outcome measure has been established yet. The criteria for TO utilised in this study were derived from those applied for TO in gastric cancer (14, 16, 51). TO for gastric cancer includes various desired and undesirable outcomes of care such as negative surgical margins, complications, prolonged duration of admission, readmission, unplanned intensive care unit admission, number of harvested lymph nodes and mortality. A notable distinction in TO criteria developed for gastric GIST in the current study compared to those for gastric cancer lies in the omission of lymph node assessment because GISTs rarely metastasise to lymph nodes (52). There is no literature yet supporting the selected outcomes for the population in this study. However, it is common for studies to adapt small parts of TO. Hopefully in the future, TO for GIST surgery will be further refined and could possibly be used as composite measure to assess the quality of care more easily.

Some limitations have to be acknowledged in this study. The first limitation is the retrospective data collection in this study. Although the patients and most data were prospectively included in the DGR, some variables had to be supplemented retrospectively, which might have resulted in selection bias. Secondly, because MIS was mostly done in later periods, long follow up data was missing. Therefore, we were not able to compare oncologic outcomes, which is something that could be done in future research. Thirdly, despite the high number of patients included in this study, the number of events are relatively low resulting in less statistical power.

Conclusion

Evaluation of resections of unifocal localised gastric GISTs in the past 13 years in the Netherlands demonstrated an increase in minimally invasive surgery, less complications, shorter duration of admissions, and stable low occurrence of tumour rupture, which is also reflected in in the increase in textbook outcome. Statistical analysis demonstrated that these improvements were correlated with minimally invasive surgery both in tumours smaller and larger than five centimetres.

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Supplementary material