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REVIEW ARTICLE

Questionnaire survey regarding the current status and controversial issues concerning reconstruction after gastrectomy in Japan

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Abstract The Japanese Society for the Study of Postoperative Morbidity after Gastrectomy conducted a nationwide questionnaire survey to clarify the current status of reconstruction after gastrectomy. One hundred and forty-five institutions (66%) responded to the survey. The questionnaire dealt with the reconstruction after a distal gastrectomy, pylorus-preserving gastrectomy (PPG), total gastrectomy, and proximal gastrectomy. The most common method of reconstruction after distal gastrectomy was Billroth I in 112 institutions (74%), and Roux-en-Y (RY) in 30 (21%). Seventy-seven institutions (53%) responded to the PPG questions. The lengths of the antral cuff were widely distributed among the institutions. Segmental gastrectomy was performed by 23 institutions for limited cases. The most common method of reconstruction after total gastrectomy was RY in 138 institutions (95%). Reconstruction with a pouch after total gastrectomy was done in 26 institutions (18%). The most common reconstructions after proximal gastrectomy were esophagogastrostomy in 69 institutions (48%), jejunal interposition in 41 (28%), double tract in 19 (13%) and pouch reconstruction in 6 (7%). Although most Japanese surgeons are concerned about the revised methods of reconstruction and quality of life after gastrectomy, surgeons have not yet reached a full consensus on these issues.

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Introduction

Theodore Billroth reported the first successful partial gastrectomy for cancer in 1881 and Carl Schlatter [1] succeeded in performing a total gastrectomy in 1897. Until the middle of the twentieth century, surgeons were primarily concerned about preventing the severe surgical complications of gastrectomy. In the 1960s, Japanese surgeons introduced the radical gastrectomy with extended lymph node dissection for gastric cancer. The Japanese clinicopathological data based on the resected materials showed that, in cases of early gastric cancer, the prognosis was excellent, and the incidence of lymph node metastasis was very low. In the 1990s, of all the cases of surgically resected gastric cancer, early cancer accounted for over 50% at each institution. This demonstrated that, even in cancer cases, Japanese surgeons should be aware of the risk of post-gastrectomy syndrome, such as weight loss, dumping syndrome, reflux esophagitis, and gall stones.

However, concerning the method of reconstruction, surgeons have not reached a full consensus for distal gastrectomy, proximal gastrectomy, and total gastrectomy. Therefore, the Japanese Society for the Study of Postoperative Morbidity after Gastrectomy (JSSPMG) conducted a nationwide questionnaire survey in November 2010 to understand the current status of reconstruction after gastrectomy in Japan. The questionnaire was sent to a total of 221 surgical institutions in the JSSPMG; 145 institutions (66%) responded to the survey. The questionnaire dealt with reconstruction of distal partial gastrectomy, the method used for pylorus-preserving gastrectomy (PPG),

reconstruction of total gastrectomy, and reconstruction of a proximal partial gastrectomy, as shown in Table 1. The questionnaire also contained the indications and the concrete method used for each reconstruction.

Distal gastrectomy

Most institutions performed several methods of reconstruction after distal gastrectomy. The questionnaire survey asked for the reconstruction methods in the order of their frequency of use. In the 145 responding institutions, the most common method of reconstruction was Billroth I (B-I) in 112 (77%), Roux-en-Y (RY) in 30 (21%), PPG in 2 (1.3%), and Billroth II (B-II) in 1 (0.7%) (Fig. 1). The second most common method of reconstruction in the institutions was RY in 91 (63%), B-I in 22 (15%), PPG in 20 (14%) and B-II in 12 (8%). There were variations in the indications for RY reconstruction. Some institutions performed the RY reconstruction as the main method, while others performed RY as an optional method in certain situations, such as when the stomach remnant was very small. The reason for choosing RY reconstruction ($n = 81$) was its low incidence of complications in 44 institutions, and the fact that it can provide a better quality of life (QOL) in 41 institutions. RY stasis was found in 53 of 75 institutions (71%) (Table 2).

The B-I method remains the most common reconstruction method for distal gastrectomy for gastric cancer. Recently, the frequency of RY reconstruction after distal gastrectomy has been gradually increasing due to benefits such as the prevention of reflux and the low complication rate [2–4]. However, RY is known to cause RY stasis, and moreover, there is some difficulty in the endoscopic approach to the bile duct system, which is often required post-gastrectomy. Furthermore, according to the questionnaire, RY stasis was reported by 71% of the institutions. Ishikawa et al. [5] reported that RY did not prevent esophagitis, because RY frequently induced RY stasis as a complication.

Pylorus-preserving gastrectomy

Of the 145 institutions, 77 (53%) responded to the PPG questions. As Fig. 2 shows, the lengths of the antral cuff (the distance from the pyloric ring) were widely distributed among the institutions. The most frequent length was 3 cm, and the next was 4 cm (Fig. 2). With regard to preserving the nerves, 73 institutions (95%) preserved the antral branch of the vagal nerve, while 53 (69%) preserved the celiac branch. Concerning the preservation of the gastric artery, 65 institutions (84%) preserved the infrapyloric artery, while 60 (78%) preserved the right gastric artery (Table 3). The tumor location for PPG was the middle third of the stomach in 44 institutions (57%), and the tumor depth was limited to early carcinoma in 76 of 77 institutions (99%).

PPG is a type of modified distal gastrectomy for the treatment of gastric ulcers, which was designed by Maki et al. [6] in 1967 as a function-preserving procedure. The purpose of PPG is to maintain the stomach capacity, thus reducing the amount of regurgitated duodenal juice by preserving the pyloric antrum, and preventing dumping syndrome. A limited lymph node dissection, as performed in the PPG operation, was shown to be a sufficiently safe and effective treatment for early gastric cancer by Kodama and Koyama [7]. While the PPG operation has several benefits, such as the prevention of dumping syndrome and duodenal juice reflux, and a low incidence of gall stones, it leads to the development of postprandial epigastric fullness and gastric stasis [8–10].

Initially, the length of the preserved pyloric cuff was 1.5 cm, as Maki et al., noted in the original article describing PPG. Subsequently, Nakane et al. [11] reported that PPG with transection of 2.5 cm proximal to the pyloric ring was superior to that with transection of 1.5 cm in terms of some postoperative symptoms and weight recovery. Nunobe et al. [12] reported a low frequency of gastric stasis in patients with a 3 cm length of pyloric cuff. Therefore, in clinical practice, the length of the preserved pyloric cuff has tended to increase, compared to that in the initial setting. Morita et al. reported a comparative clinical study in which they classified patients into two groups according to the length of the antral cuff (groups with cuffs 3 cm and smaller and those with cuffs over 3 cm) and investigated their postoperative QOL. Their results did not reveal any significant difference between the two groups [13]. The discrepancy in the clinical data for PPG is likely caused by dealing with nerve preservation, the length of the antral cuff, and the extent of lymph node dissection.

According to the questionnaire, the length of the antral cuff has recently shifted from the original length reported by Maki et al. to 3–4 cm or more, thus suggesting that segmental gastrectomy is better than PPG for preserving gastric function. The extension of the antral cuff makes the difference between the PPG and segmental gastrectomy (SG) less clear. More discussion will be needed to more clearly define PPG and SG. However, both PPG and SG should be performed for cases of early gastric cancer from the perspective of lymph node dissection. Especially for SG, it is better to subsequently perform sentinel node mapping.

Segmental gastrectomy

Twenty-three institutions had performed at least one segmental gastrectomy. The indications for SG were as

Table 1 Questionnaire about reconstruction after gastrectomy

1. Reconstruction after distal gastrectomy (The questionnaire asks for the reconstruction methods in the order of frequency.)

A. Billroth I, B. Billroth II, C. Roux-en Y, D. Pylorus preserving gastrectomy (PPG)

E. Jejunal interposition

2. Question for institutions performing Roux-en Y

1) Reason for choosing (check as many as necessary)

A. Low risk of postoperative complication, B. Convenient method, C. Better quality of life

2) Occurrence of Roux-en Y stasis: yes or no

3) Standard reconstruction: yes or no

3. Question for institutions performing PPG

1) Length of antral cuff ( ) cm

2) Nerve preservation

A. Antral branch, B. Celiac branch, C. Other

3) Preservation of infrapyloric artery: yes or no

4) Preservation of right gastric artery: yes or no

5) Indication: limited to early cancer or up to advanced cancer

6) Tumor location ( )

4. Question for institutions performing segmental gastrectomy

1) Indication ( )

2) Sentinel node navigation: yes or no

3) Difference between PPG and segmental gastrectomy ( )

5. Reconstruction after total gastrectomy (The questionnaire asks about the reconstruction methods in the order of frequency.)

A. Jejunal interposition, B. Roux-en Y, C. Double tract, D. Other

6. Question for institutions performing pouch reconstruction after total gastrectomy

1) Purpose of pouch reconstruction (check as many as necessary)

A. Increasing food intake, B. Prevention of reflux esophagitis, C. Prevention of dumping syndrome D. Other

2) Site of pouch

A. Esophageal side, B. Anal side, C. Other

3) Length of pouch ( ) cm

4) Procedures to prevent esophageal reflux: yes or no

How do you do it? ( )

5) Reconstruction

A. Jejunal interposition, B. Roux-en Y, C. Double tract, D. Other

7. Reconstruction after proximal gastrectomy (1) (The questionnaire asks about the reconstruction methods in the order of frequency.)

A Esophago-gastrostomy, B. Jejunal interposition, C. Double tract, D.Pouch reconstruction, E.Other

8. Reconstruction after proximal gastrectomy (2)

1) Indication ( )

2) Size of stomach remnant

A. Over 1/2 of entire stomach, B. Under 1/2, C. Depending on the case

3) Length of the interposition ( ) cm

4) Length of the pouch ( ) cm

5) Nerve preservation: yes or no

6) Approach to prevent reflux ( )

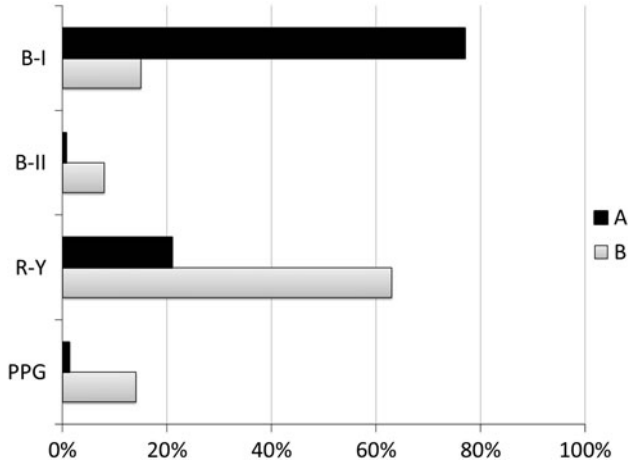

Fig. 1 Reconstruction after distal gastrectomy ($n = 145$). *A* The most common method of reconstruction after distal gastrectomy; *B* the second most common method of reconstruction after distal gastrectomy. *B-I* Billroth I, *B-II* Billroth II, *R-Y* Roux-en-Y, *PPG* pylorus-preserving gastrectomy

Table 2 Roux-en-Y reconstruction after distal gastrectomy

A	Low risk of complication	Good quality of life	Other
	44 (54%)	41 (51%)	20 (25%)
B	Yes	No	
	53(71%)	22(29%)	

A: the reason of choosing Roux-en-Y reconstruction ($n = 81$)

B: occurrence of Roux-en-Y stasis ($n = 75$)

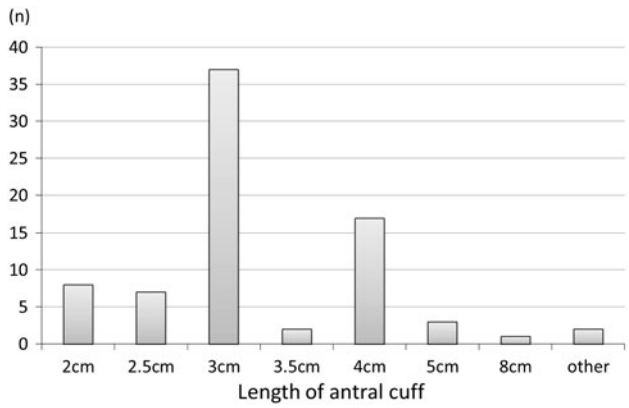

Fig. 2 The length of the antral cuff ($n = 77$)

follows: (1) early cancer located in the middle third of the stomach whose length from the pyloric ring was long enough (4–8 cm); (2) mucosal or submucosal cancer; and (3) lesions with only a few lymph node metastases, for which endoscopic therapy (EMR, ESD) was not adaptable.

SG with sentinel node navigation was performed in 9 of 23 institutions. According to the questionnaire about differences from PPG, the length of the antral cuff was short in PPG cases, while it is long in SG cases, and SG is categorized as a local resection, while PPG is categorized as a type of distal gastrectomy. However, there is still no clear consensus on the concept of SG.

Table 3 Pylorus-preserving gastrectomy

	Preserved	Not preserved
Nerve preservation		
Antral branch ($n = 77$)	73 (95%)	4 (5%)
Celiac branch ($n = 77$)	53 (69%)	24 (31%)
Gastric artery preservation		
Infrapyloric artery ($n = 77$)	65 (84%)	12 (16%)
Right gastric artery ($n = 77$)	60 (78%)	17 (22%)

SG was originally performed for the treatment of peptic ulcers to preserve gastric motility, and several modifications were subsequently developed to resolve the delayed emptying time. The concept of SG for gastric cancer is completely different from that for gastric ulcers. The indication for SG for gastric cancer is limited, similar to PPG. Fujimura et al. [14] proposed a new SG technique using sentinel node navigation for early cancer located in the middle third of the stomach. The results of the questionnaire survey showed that only 23 institutions (16%) performed SG.

Total gastrectomy

In the 145 institutions, the most common method of reconstruction after total gastrectomy was RY in 138 (95%), interposition in 2 (1.4%), and double tract in 1 (0.7%) (Fig. 3). Reconstruction with a pouch was done in 26 institutions. The majority of reconstructions with a pouch were RY (25 of 26 institutions, 96%). The purpose of pouch reconstruction after total gastrectomy was to: increase the food intake at each meal in 23 institutions (88%); prevent reflux esophagitis in 6 (26%); and to prevent dumping syndrome in 8 (35%). The site of the pouch was located at the proximal side in 20 institutions (77%) and at the distal side in 6 (23%) (Table 4). Of all of the lengths of the pouch reported by 25 institutions, the most common ones were 10 cm in 9 institutions (36%), 15 cm in 7 (28%), and 5 cm in 5 (20%) (Fig. 4).

Many surgeons previously performed jejunal interposition or double tract reconstruction after total gastrectomy to increase the duodenal passage of foodstuffs, which was considered to be very important. As the questionnaire survey showed, the majority of institutions have recently chosen RY as the reconstruction method after total gastrectomy. This is due to the fact that there is no inferiority

Fig. 3 The reconstruction method employed after total gastrectomy. **a** The most common method of reconstruction after total gastrectomy ($n = 145$), **b** the most common method of reconstruction with a pouch after total gastrectomy ($n = 26$). *R-Y* Roux-en-Y, *interposition* jejunal interposition

Table 4 Pouch reconstruction after total gastrectomy

Purpose of pouch	Increasing food intake at each meal	Prevention of reflux esophagitis	Prevention of dumping syndrome
($n = 26$)	23 (88%)	6 (26%)	8 (35%)
Site of pouch	Proximal side	Distal side	
($n = 26$)	20 (77%)	6 (23%)	

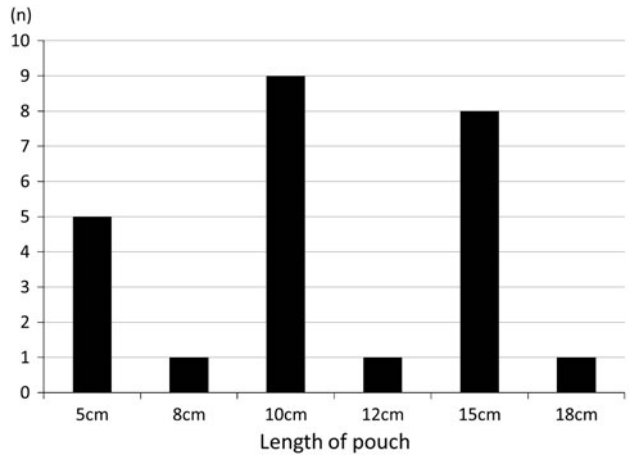

Fig. 4 The length of the pouch used after total gastrectomy

in the rate of postoperative late complications compared to the interposition or double tract methods. Moreover, several investigators have described that there were no differences in a study comparing a jejunal interposition and a RY reconstruction after total gastrectomy [15, 16].

The purpose of reconstruction with a jejunal pouch after total gastrectomy is to increase the reservoir capacity for ingested food. However, the benefits of this method of reconstruction are not yet obvious, and a jejunal pouch cannot yet be considered a standard reconstructive method. Some reports supported the advantage of pouch reconstruction after total gastrectomy [17–20]. For example, Shibata et al. [21] reported in their review article that six reports where pouch RY reconstruction was used showed improvements in body weight, QOL, eating capacity, and reflux symptoms compared to RY reconstruction without a pouch, while three reports showed no difference.

One issue that arises when the surgeon considers a jejunal pouch as part of the reconstruction after total gastrectomy is the pouch length. Most studies have described a pouch of about 15 cm in length, so any comments regarding the optimal length of the pouch must be considered anecdotal, at best [22]. Tono et al. and Tanaka et al. [23, 24] both stated that pouches longer than 15 cm may contribute to symptoms of stasis, and their observations substantiate this. Other studies have suggested that the smaller pouches (5 and 10 cm) result in little benefit [22]. Concerning the site of the pouch after total gastrectomy, it did not significantly affect the QOL or outcome [25]. As the questionnaire survey for pouch reconstruction showed, the distribution of the pouch length varied widely, and the site of the pouch was generally constructed on the oral side.

We hope that these more recent data on the outcomes of a pouch approach to reconstruction after total gastrectomy will encourage those surgeons still using simple esophagojejunostomy reconstruction to consider a jejunal pouch reconstruction.

Proximal gastrectomy

In the 145 institutions that responded to the questionnaire, the most common reconstructions after proximal gastrectomy were esophagogastrostomy in 69 institutions (48%), jejunal interposition in 41 (28%), double tract in 19 (13%), and pouch reconstruction in 6 (7%); 12 institutions (8%) did not respond to that question. There were 92 institutions (63%) that had performed a proximal gastrectomy for early gastric cancer located in the upper stomach. In the remaining institutions, it was performed for advanced cancer located in the upper stomach. Regarding the size of the stomach remnant, it was over half of the entire stomach in 91 of 112 institutions (71%). As for nerve preservation, 66 of 112 institutions (59%) performed nerve-preservation operations, while the other 44 institutions (41%) operated without nerve preservation (Fig. 5). The most common lengths of the interposed jejunum were 10 cm in 18 of 39 institutions (46%) and 15 cm in 11 (28%).

Proximal gastrectomy is now gaining recognition as one of the modified operations for early gastric cancer. Proximal gastrectomy was formerly done only for cases in which the stomach remnant was less than one-third of the original stomach, and it was generally necessary to reconstruct it

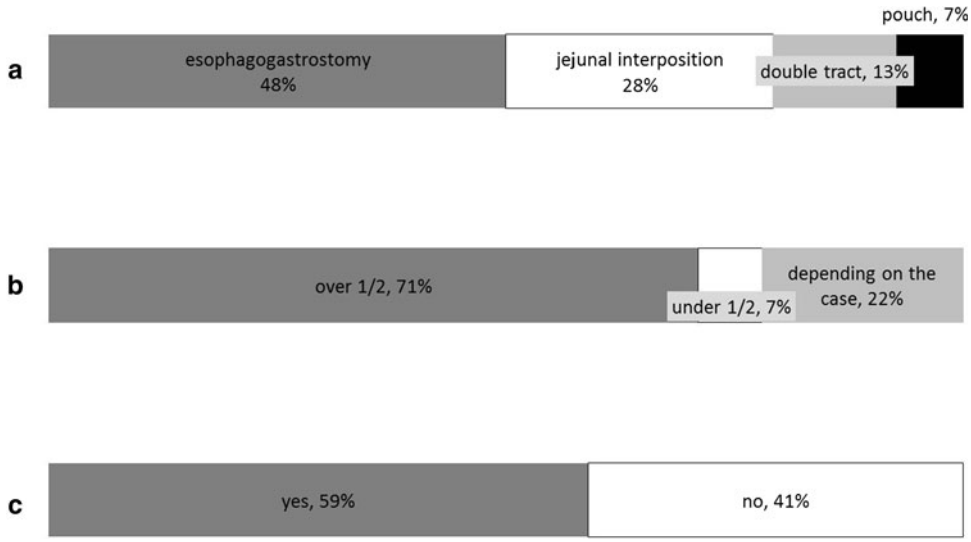

Fig. 5 Reconstruction after proximal gastrectomy. **a** The most common method of reconstruction after proximal gastrectomy ($n = 145$), **b** the size of the stomach remnant ($n = 120$), **c**: vagal nerve preservation (hepatic branch and/or celiac branch) ($n = 112$). Over 1/2, over half of the entire stomach; under 1/2, under half of the entire stomach

with a jejunal interposition to prevent reflux esophagitis. However, most institutions now perform a proximal gastrectomy when the stomach remnant can be more than one-half, since it is expected to be functional after gastrectomy using this method. Moreover, this modification has also resulted in the replacement of jejunal interposition with end-to-side esophagogastrostomy. Several reports have described the benefits of pouch-esophagostomy after proximal gastrectomy [26, 27]. According to this questionnaire survey, only 6 institutions (7%) performed pouch reconstruction after proximal gastrectomy. An evaluation of pouch reconstruction after proximal gastrectomy should be performed in the future to determine whether it should be more widely applied.

Conclusion

The JSSPMG performed a national questionnaire survey to investigate the current status of reconstruction after gastrectomy in Japan. Although most Japanese digestive surgeons are concerned with revising the methods used for reconstruction and with the patient QOL after gastrectomy, there is not yet a full consensus regarding the best methods or the precise indications for each. Because the data from uncontrolled case series are notoriously difficult to interpret, a prospective, multicenter, randomized, controlled study will be needed to overcome these difficulties.

Appendix: Institutions

Aizawa Hospital, Aomori Prefectural Central Hospital, Arita GI Hospital, Asahikawa Medical University, Asahikawa-Kosei General Hospital, Chiba Cancer Center, Chiba Medical Center, Chiba University, Dokkyo University Surgery 1, Dokkyo University Surgery 2, Fujisawa City Hospital, Fujita Health University, Fujita Health University Banbuntane Hotokukai Hospital, Fukui Red Cross Hospital, Fukushima Medical University, Funabashi Municipal Medical Center, Gifu University, Gosyogawara City Seihoku Hospital Easy, Gunma University, Gunma University Hospital, Himeji Central Hospital, Hirosaki University, Hiroshima City Asa Hospital, Hiroshima City Hospital, Hiroshima University, Hokkaido Cancer Center, Hokkaido Gastroenterology Hospital, Hoshigaoka Koseinenkin Hospital, Hyogo Cancer Center, Hyogo University, Iizuka Hospital, International University of Health and Welfare Mita Hospital, Ishikawa Prefectural Central Hospital, Iwate Medical University, Izumi Municipal Hospital, Jichi Medical University, Jichi Medical University Saitama Medical Center, Jikei University, Jikei University Aoto Hospital, Jikei University Kashiwa Hospital, Juntendo University, Juntendo University Shizuoka Hospital, Juntendo University Urayasu Hospital, Kagoshima University Surgery1, Kagoshima University Surgery2, Kanagawa Cancer Center, Kanazawa Medical University, Kansai Medical University Hirakata Hospital, Kansai Rosai Hospital, Keio University, Kimitsu Chuo Hospital, Kinki University, Kitasato Institute Hospital, Kitasato University, Kosei Hospital, Koube University, Kouchi University, Kumamoto University, Kurume University, Kyoto Prefectural University of Medicine, Kyoto Second Red Cross Hospital, Kyourin University, Kyushu University, Matsuyama Shimin Hospital, Minoh City Hospital, Nagahama City Kohoku General Hospital, Nagasaki Medical Center, Nagasaki University, Nagoya City University, Nagoya Ekisaikai Hospital, Nagoya University, Nanpuh Hospital, Nara Medical University, National Cancer Center, National Cancer Center Hospital East, National Defenes Medical

College, National Hospital Kyushu Medical Center, National Kyushu Cancer Center, Niigata Cancer Center, Niigata City General Hospital, Niigata Prefecture Yoshida Hospital, Niigata University, Nippon Medical school, Nippon Medical school Musashi Kosugi Hospital, NTT West Osaka Hospital, Okayama Saiseikai General Hospital, Okayama University, Osaka City University Surgery1, Osaka City University Surgery2, Osaka Koseinenkin Hospital, Osaka Medical Center for Cancer and Cardiovascular Diseases, Osaka University, Saga Prefectural Hospital Koseikan, Saiseikai Noe Hospital, Saitama City Hospital, Saitama Medical University International Medical Center, Saitama Medical University Medical Center, Sakai Municipal Hospital, Saku Central Hospital, Sapporo Medical University, Seirei Hamamatsu General Hospital, Sendai Medical Center, Shiga University of Medical Science, Shikoku Cancer Center, Shinshu University, Shiso Municipal Hospital, Shizuoka Cancer Center, Showa University Fujigaoka Hospital, Social Insurance Chuo General Hospital, South Miyagi Medical Center, St.Marianna University, Teikyo University, Teikyo University Mizonokuchi Hospital, The University of Tokyo, Tochigi Cancer Center, Tochigi National Hospital, Toho University Ohashi Hospital, Toho University Omori Medical Center, Tohoku Rosai Hospital, Tokai University Tokyo Hospital, Tokyo Medical and Dental University Esophagogastric surgery, Tokyo Medical and Dental University Surgical Oncology, Tokyo Medical University, Tokyo Medical University Ibaraki Medical Center, Tokyo Metropolitan Bokutoh Hospital, Tokyo Metropolitan Komagome Hospital, Tokyo Women's Medical University, Tokyo Women's Medical University Center East, Tottori University, Toyama Rosai Hospital, Toyohashi Municipal Hospital, Toyonaka Municipal Hospital, Tsuruoka Municipal Shonai Hospital, University of Fukui, University of the Ryukyu, University of Toyama, University of Yamanashi, Wakayama Medical University, Wakayama Rosai Hospital, Yamagata Perfectural Central Hospital, Yamagata University, Yokohama City University, Yokohama City University Medical Center, Yonezawa City Hospital.

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