

# Duodenogastrojejunum Annular Internal Drainage for Superior Mesenteric Artery Syndrome: A Modified Staveley's Surgery

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**INTRODUCTION:** Superior mesenteric artery syndrome (SMAS) is caused by acute or chronic compression of the third part of the duodenum in the aortomesenteric angle. Staveley's duodenojejunostomy (DJ) is an option when conservative management fails. In current case study, we reported a modified technique in treating the young patients who presented with a long-term history of intractable SMAS.

**METHODS:** Twelve patients presented with history of supper abdominal pain, nausea, distension and postprandial vomiting as well as weight loss. The finding of a significant narrowing of aortomesenteric angle and substantial duodenal compression established by endoscopic ultrasound and contrast-enhanced spiral CT, was in good agreement with a diagnosis of SMAS. Conservative treatment including enteral feeding failed to relieve the symptoms. Five cases were performed by traditional DJ and the other seven patients were applied with a modified DJ by duodenum-gastro-jejunum annular internal drainage. The patient health-related quality of life was evaluated by EQ-5D and SF-12 in all the cases within 1-yr and 3-yr follow ups.

**RESULTS:** There was no marked intra-abdominal hemorrhage, anastomotic leakage, postoperative infection and stromal hemorrhage / ulcers in all cases. There was no difference with respect to the intraoperative blood loss and urine output, and postoperative emerging time of negative fluid balance between the DJ and modified DJ groups. Compared to the traditional DJ, the modified procedure had an increased operation time ( $2.67 \pm 0.29$  vs  $1.83 \pm 0.29$ ,  $P=0.03$ ) and surgical stress score (SSS) ( $0.19 \pm 0.02$  vs  $0.14 \pm 0.01$ ,  $P=0.02$ ). Within postoperative one-month, sixty percent (3 cases) of DJ group had recurrent vomiting and epigastric pain and one patient need reoperation. During the 1-year and 3-year follow-ups, the recurrence cases of intermittent abdominal pain, distension and nausea were two and one respectively in DJ group. The patients in both groups showed increased weight gains in the follow ups. The patients with the modified DJ surgery showed not reflux gastritis, anastomotic ulcer and stricture with a complete relief of symptoms and a relatively higher SF-12 (PCS) compared to the DJ surgery (1-yr:  $30.5 \pm 3.1$  vs  $36.9 \pm 3.2$ ,  $P=0.04$ ; 3-yr:  $32.1 \pm 3.1$  vs  $38.9 \pm 3.2$ ,  $P=0.04$ ).

**CONCLUSION:** The case study showed that the modified procedure with duodenum annular internal drainage is feasible in relieving the symptoms when conservative treatment fails in young adults with SMAS. The new procedure increases surgery time and SSS. However, it potentially reduces the recurrence rate and postoperative complications of duodenal obstruction and antiperistalsis and improves quality of life. Further study will be required for effectiveness and safety of the modified procedure in the people with SMAS with longstanding history. ■

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**I**N 1974, Akin named the disease “duodenal vascular compression syndrome”, also known as superior mesentery artery syndrome (SMAS). Main pathological change is the obstruction of the horizontal part of duodenum which passes through the aortomesenteric vascular angle. The SMA is normally around with fat and lymphatic tissues, which prevents the part of duodenum excessive compressed. It has been recognized that any condition that narrows the aortomesenteric angle to approximately 6 – 16 degrees can lead to compression of the duodenum between the abdominal aorta and the superior mesenteric artery with resultant epigastric pain and frequent vomiting (1-3). In addition, frequent attack for a long period can also lead to duodenal antiperistalsis to result in vomiting and weight loss.

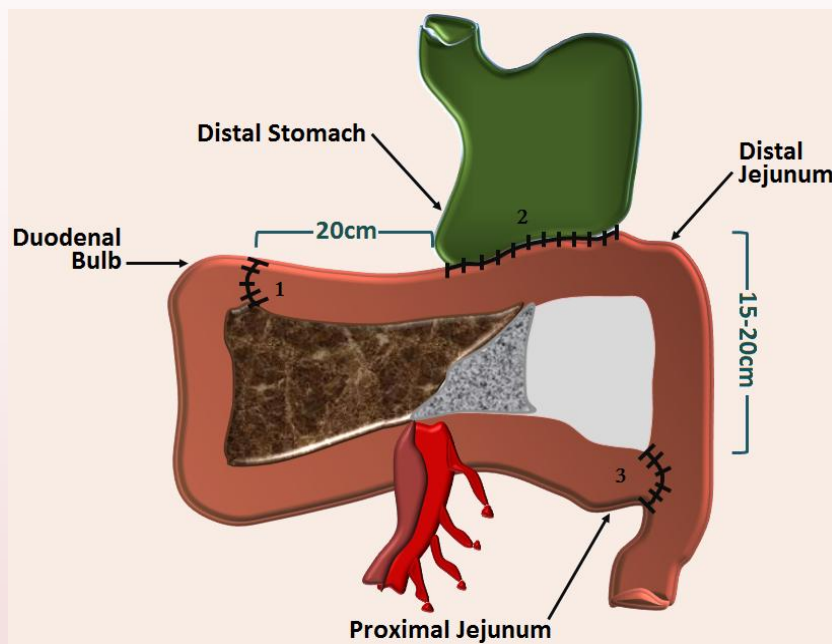
Several surgical procedures have been developed and the common characteristic of these surgical concepts is to perform a small-bowel bypass-procedure and to accompany the disruption of the physiologic intestinal continuity. For example, lysis of Treitz ligament - a feasible and safe technique (4), is chosen to treat the SMAS caused by shortage of duodenal-jejunum suspensory ligament. Subtotal gastrectomy and gastro-jejunosomy can alleviate clinical symptoms if peptic ulcer is accompanied. In 1919, Staveley firstly applied side-to-side duodenojejunosomy with proximal jejunum 10cm away from Treitz ligament-the anastomotic diameter > 5 cm (5). This method is advantageous owing to not only little injury but also simple procedure. Recently there have been a few reports of laparoscopic duodenojejunosomy,

and minor operative injury and faster recovery are the advantages (6-9). A developed operation offers an improved anastomotic approach through Roux-en-Y anastomosis. Recurrent rate is approximately 20%-30% after duodenojejunosomy. The possible reasons are unresolved duodenal antiperistalsis, the forming blind loop between anastomosis and duodenal obstructed region causing gastrointestinal contents stasis – blind loop syndrome, And duodenal cyclic muscles being resected at the area of anastomosis affecting its peristalsis. However, our clinical investigation and recent data showed that duodenal antiperistalsis and incomplete relief of symptoms exist after the procedure in those with longstanding history of SMAS. A recent study by Pourhassan et al showed a new surgical approach in performing a successful transposition of the superior mesenteric artery into the infrarenal aorta with 5-0 poly-dioxanone suture in a single-stitch technique (3). It consists of removal of the compressing from SMA, thus avoiding contact and compression of the duodenum. However, the proficient skill of vascular suturing and perioperative management in vascular surgery is indispensable for surgeons. Moreover, the postoperative antiperistalsis still exists. Consequently, ideal surgical procedure must aim at alleviating the obstruction of horizontal duodenum and improving antiperistalsis simultaneously. The purpose of our study is to elucidate the safety and efficacy of a new surgical procedure to solve both the obstruction of horizontal duodenum and antiperistalsis.

## METHODS

From March 2003 to September 2011, a total of 12 patients, diagnosed as superior mesenteric artery (SMA) syndrome by gastrointestinal barium meal X-ray examination, sonography and CT-angiography – the SMA-aortic angle decreased by 60% (normal range from 30° to 45°)(1, 7-9) and underwent surgical therapy, were analyzed retrospectively. Written informed consent was obtained from the patients' family before enrollment and they had the right to withdraw before operation day. All the information of patients kept private and informed consent forms were approved by the Ethics Committee for Clinical Pharmacology at Tongji Medical College. Relevant animal experiments had not been run before. In the current study, all patients were applied total preteral nutrition support. It is implemented at first followed by enteral nutrition through nasointestinal catheter when ileus relieves. After the catheter enters the duodenum, the patient should need a knee-chest position to make the rotated bottom of the catheter pass through the horizontal part of duodenum and enter jejunum. Intravenous hyperalimentation with high caloric nutrition had been infused by infusion pump continuously over 18 h daily.

There were 4 patients to run duodenojejunosomy (DJ) and the other 4 cases to be treated by duodenum-gastro-jejunum annular internal drainage (**Figure 1**) during the first operation. The jejunum 10-15cm away from Treitz ligament was cut off, and then distal gastrectomy was performed. End-to-end anastomosis was established between the distal jejunum and duodenal bulb. Then

**Figure 1. The Modified Duodenojejunostomy Procedure**

1=Anastomosis between duodenal bulb and distal jejunum;  
 2=Anastomosis between distal stomach and distal jejunum;  
 3=Anastomosis between distal jejunum and proximal jejunum.

end-to-side anastomose was brought 15-20 cm below away the gastro-jejunostomy anastomosis between the proximal jejunum and distal jejunum.

Surgical invasion was evaluated by surgical stress score (SSS) (10, 11), calculated by the following formula:  $-0.342+0.0139X_1+0.0392X_2+0.352X_3$ .  $X_1$  represents blood loss/body weight (g/kg);  $X_2$  represents operation time (h);  $X_3$  indicates extent of skin incision (0 indicates a minor incision for laparoscopic or thoracoscopic surgery including laparoscopic-or thoracoscopic-assisted surgery; 1 indicates laparotomy or thoracotomy alone; 2 represents laparotomy and thoracotomy). In order to further health-related quality of life evaluation through the clinical intervention process, we exerted EuroQol-5 Dimensions questionnaire (EQ-5D) and SF-12. EQ-5D tracked the health status

with five dimensions including mobility, self-care, usual activities, pain / discomfort and anxiety / depression and there were three levels in each dimension questionnaire. SF-12 questionnaire was designed to perform the physical components summary (PCS) and mental health component summary (MCS). The translated version of EQ-5D and SF-12 were recently recommended in the analysis of quality of life among the Asian (12-15).

Continuous variables such as age, body weight, BMI, albumin and transthyretin were reported as mean  $\pm$  SD and categorical variables as number (n). Between-groups differences were assessed using t test or Fisher exact test as appropriated and  $P < 0.05$  indicated significant differences.

## RESULTS

## Preoperative Clinical Characteristics

Baseline characteristics of the two groups were similar with respect to age, sex, weight, body mass index (BMI), serum albumin, hemoglobin and transthyretin (Table 1).

## Primary Outcomes

The perioperative characteristics of the patients were displayed in Table 2. The mean volume of blood loss and urine output in the both groups, were not significantly different. The mean surgery time in the DJ group was significantly lower than the modified DJ group ( $1.83 \pm 0.29$  vs  $2.67 \pm 0.29$ ,  $P=0.03$ ). The higher surgical stress score was found in the modified DJ group ( $0.14 \pm 0.01$  vs  $0.19 \pm 0.02$ ,  $P=0.02$ ). Two of 4 patients who were performed side-to-side duodeno-jejunostomy vomited frequently two weeks after surgery, but only one of two patients alleviated after conservative therapy such as acupuncture, gastrointestinal decompression and parenteral nutrition. The other one had to be run Roux-en-Y duodenojejunostomy. Unfortunately, the latter vomited frequently owing to duodenal antiperistalsis one month after the second surgery. The emerging time of negative fluid balance was similar between the groups. No significant complications were found in intra-abdominal hemorrhage, upper gastrointestinal hemorrhage, anastomotic leakage, incision infection, intra-abdominal infection and postoperative ileus in both groups. Recurrence of nausea/vomiting and pain occurred in DJ but not modified DJ with the duodenum-gastro-jejunum annular internal drainage.

## Secondary Outcomes

The postoperative clinical profiles of patients were delineated in Table 3. The duration of follow-up included 1-year and 3-year and overall recurrence rates were 40% (2/5) and 30% (1/5) respectively in DJ group. In the

**Table 1. General characteristics of the subjects at baseline.**

Characteristic	DJ group (N=5)	Modified DJ group (N=7)
Age (yr)	23.33 ± 5.50	26.00 ± 3.00
Male	2	2
Female	3	5
Weight (kg)	43.33 ± 8.5	43.58 ± 7.50
BMI (kg/m <sup>2</sup> )	17.23 ± 4.6	17.42 ± 5.98
Duration of symptom (month)	24.6 ± 6.2	25.7 ± 7.9
Cause	Congenital	Congenital
ASA PS level		
I	2	3
II	3	4
Hgb (g/L)	106.33 ± 11.15	108.28 ± 12.77
Alb (g/L)	37.67 ± 2.50	37.0 ± 1.00
Transthyretin (mg/L)	251.67 ± 21.03	242.00 ± 19.67

DJ, duodenojejunostomy. DGJ, duodeno-gastro-jejunum annular internal drainage. ASA PS, American society of anesthesiologists' physical status classification. Alb, albumin. Hgb, hemoglobin.

**Table 2. Perioperative outcomes by DJ or DGJ procedures.**

Characteristic	DJ group (N=5)	Modified DJ group (N=7)	P value
<b>Intraoperative</b>			
Surgery time(h)	1.83 ± 0.29	2.67 ± 0.29	0.033
Blood loss (ml)	166.67 ± 28.87	216.67 ± 28.87	0.065
Blood transfusion (n)	0	0	n/a
Urine output (ml/H)	283.33 ± 28.87	316.67 ± 28.87	0.071
SSS evaluation	0.14 ± 0.01	0.19 ± 0.02	0.024
<b>Postoperative event (30 days)</b>			
Intra-abdominal hemorrhage (n)	0	0	n/a
Upper gastrointestinal hemorrhage (n)	0	0	n/a
Duration of negative fluid balance (h)	18.74 ± 4.55	20.18 ± 6.94	0.07
Anastomotic leakage (n)	0	0	n/a
Infection (n)	0	0	n/a
Ileus (n)	0	0	n/a
Anastomotic ulcer (n)	0	0	n/a
Anastomotic stricture (n)	0	0	n/a
Reflux gastritis (n)	0	0	n/a
Recurrent nausea/vomiting (n)	3	0	0.023
Recurrent distension/epigastric pain (n)	3	0	0.023
Reoperation (n)	3	0	0.023

DJ, duodenojejunostomy. DGJ, duodeno-gastro-jejunum annular internal drainage. ASA PS, American Society of Anesthesiologists' physical status classification. Infection occurred in incision or intra-abdominal field.

Table 3. Postoperative outcomes in 1-year and 3-year follow ups after surgery.

Event	1-year			3-year		
	DJ group (N=5)	Modified DJ group (N=7)	P value	DJ group (N=5)	Modified DJ group (N=7)	P value
BW (kg)	51.92 ± 6.11	54.94 ± 5.75	0.072	52.17 ± 6.51	56.44 ± 5.29	0.068
BMI (kg/m <sup>2</sup> )	19.66 ± 4.43	20.83 ± 3.61	0.081	19.99 ± 4.71	21.52 ± 3.55	0.066
Anastomotic ulcer (n)	0	0	n/a	0	0	n/a
Anastomotic stricture (n)	0	0	n/a	0	0	n/a
Reflux gastritis (n)	0	0	n/a	0	0	n/a
Recurrent nausea or vomiting (n)	2	0	0.038	1	0	0.047
Recurrent distension or epigastric pain (n)	2	0	0.038	1	0	0.047
EQ - 5D index (0-1) score	0.60 ± 0.06	0.64 ± 0.07	0.082	0.63 ± 0.06	0.67 ± 0.07	0.089
SF-12						
PCS	30.5 ± 3.1	36.9 ± 3.2	0.04	32.1 ± 3.1	38.9 ± 3.2	0.04
MCS	44.1 ± 4.5	45.1 ± 4.6	0.092	46.7 ± 4.9	47.7 ± 4.4	0.098

EQ-5D, EuroQol-5 dimensions questionnaire; PCS, the physical component summary score; MCS, mental health component summary score.

modified DJ group, 7 patients to run duodeno-gastro-jejunum annular internal drainage recovered well without associated complications such as anastomotic ulcer, anastomotic stricture, reflux gastritis and malnutrition.

## DISCUSSION

In young adults with acute and sub-acute episodes of SMAS, conservative treatments are recommended. The gastrointestinal decompression, correction of dehydration and electrolyte imbalance, nutrition support therapy and acupuncture should be performed especially when the cause is confirmed (16). Most of the patients with chronic symptoms require surgical intervention. Surgical indications include: (i) failure of nonsurgical treatment, (ii) emaciation associated with reduced intake for a long period and no weight gain, (iii) conspicuous dilation of duodenum, and (iv) concomitant peptic ulcer. Clinical history of the eight patients in the study was from  $25.1 \pm 7.2$  months, and they were executed surgical procedure after conservative treatment proved failure.

Our preliminary results showed that laparoscopic duodenojejunostomy obtained relief of symptoms and weight gain in the 3-year follow up. However, duodenum annular internal drainage is the preferred surgical procedure for the patient with the history of more than 2 years and violent antiperistalsis. The modified procedure was safe and the 5 patients tolerated oral feeds and diet. After discharged on postoperative one-week, the patient remained well and asymptomatic during follow-up at 3 years. The current preliminary study showed this procedure is feasible and effective in young adults with the following indications (i) over 2 years history; (ii) recurrent vomiting with no relief when position is alternated; (iii) duodenal bulb and descending segment seem dilated significantly with violent antiperistalsis, and pyloric channel opens in barium meal X-

ray examination, and (iv) recurrence after duodenojejunostomy.

Compared to traditional DJ, the new procedure increases surgery time and causes high SSS. However, it potentially reduces the recurrence rate and complications of duodenal obstruction and antiperistalsis after duodenojejunostomy surgery and resultant quality of life. Further study will be required for effectiveness and safety in future investigation of the modified procedure in the people with SMAS with longstanding history. ■

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## Conflict of Interests

None

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