



## ARAŞTIRMA / RESEARCH

# Çocuklarda roux en Y jejunal anastomozda stapler kullanımı ile elle anastomozun karşılaştırılması

Comparison of stapler and hand-sewn roux en Y jejunal anastomosis in children

Murat Alkan<sup>1</sup>, Kamuran Tutuş<sup>1</sup>, Ender Fakioğlu<sup>1</sup>, Selcan Türker Çolak<sup>1</sup>, Şeref Selçuk Kılıç<sup>1</sup>, Önder Özden<sup>1</sup>, Recep Tuncer<sup>1</sup>

<sup>1</sup>Çukurova University Faculty of Medicine, Department of Pediatric Surgery, Adana, Turkey

<sup>2</sup>Başkent University, Ankara Hospital, Department of Pediatric Surgery, Ankara, Turkey

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### Abstract

**Purpose:** This study aims to evaluate and compare the outcomes of stapled and hand-sewn Roux-en-Y intestinal anastomoses in childhood.

**Materials and Methods:** At a university hospital, the records of the children who underwent roux-en-Y anastomosis between December 2007 and December 2014 were reviewed. The data were compared according to the roux-en-Y anastomosis technique used (stapled versus hand-sewn).

**Results:** A total of 52 patients had undergone roux-en-Y anastomosis. All had biliary atresia or choledochal cyst. Thirty-one of the patients were diagnosed with biliary atresia and 21 with choledochal cysts. Staple anastomosis technique was used in 16 of the patients with biliary atresia and 9 of the patients with choledochal cyst. Both in biliary atresia and choledochal cyst cases; operations with stapled anastomosis were significantly shorter than the ones with hand-sewn anastomosis. Among the biliary atresia cases, post-operative oral feeding was initiated significantly earlier in the stapled group, with its lower risks of post-operative cholangitis and longer hospital stay than 7 days.

**Conclusion:** This is the first study in children, confirming the time-saving advantage of stapled anastomosis over hand-sewn, during roux-en-Y anastomosis for biliary atresia and choledochal cyst; along with the safety of stapler use, including the neonates. Stapled anastomosis yields lower complication rates, faster function gain with earlier feeding and hospital discharge.

**Keywords:** Roux en Y; anastomosis; stapler; children

### Öz

**Amaç:** Bu çalışma çocukluk çağında elle ve stapler ile yapılan roux en Y bağırsak anastomozunun sonuçlarının karşılaştırılmasını amaçlamaktadır.

**Gereç ve Yöntem:** Bir üniversite hastanesinde Aralık 2007 ile Aralık 2014 tarihleri arasında roux-en-Y anastomozu yapılan çocukların kayıtları incelendi. Veriler anastomoz tekniğine göre sınıflandırılıp kıyaslandı.

**Bulgular:** Toplamda 52 hastaya roux en Y anastomozu uygulandı. Hastaların biliyer atrezi veya koledok kisti tanıları vardı. Hastaların 31'i biliyer atrezi, 21'i ise koledok kisti tanılı idi. Biliyer atrezili hastaların 16'sında, koledok kisti hastalarının 9'unda stapler anastomoz tekniği kullanıldı. Hem biliyer atrezi hem de koledok kisti olgularında stapler ile anastomoz yapılanların operasyon süreleri elle anastomoz yapılanlara göre anlamlı olarak daha kısaydı. Biliyer atrezili grupta stapler ile anastomozda oral beslenme anlamlı olarak daha erkendi). Ayrıca bu grupta postoperatif kolanjit ve 7 günden uzun hastanede kalış riski daha düşüktü.

**Sonuç:** Bu çalışma çocuklarda biliyer atrezi ve koledok kistinde roux en Y için stapler ile anastomozun elle anastomozla göre zaman kazandırma avantajını doğrulayan ilk çalışmadır. Yenidoğanlar da dahil olmak üzere stapler kullanımının güvenli olduğunu belirtmektedir. Stapler ile anastomoz daha düşük komplikasyon, daha erken beslenme ve daha az hastanede yatış üzerinde olumlu etki sağlamaktadır.

**Anahtar kelimeler:** Roux en Y, anastomoz, stapler, çocuklar

Yazışma Adresi/Address for Correspondence: Dr. Kamuran Tutuş, Çukurova University Faculty of Medicine, Department of Pediatric Surgery, Adana, Turkey E-mail: kamurantt@hotmail.com  
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## INTRODUCTION

Roux-en-Y anastomosis (RYA) is a common method of creating a non-anatomical route for ingested nutrients and/or gastrointestinal secretions, using jejunum. This “Y”-shaped jejunal loop creating procedure was named after Dr. César Roux who first performed it in 1892 for gastric outlet obstruction. Later on, it has been a crucial part of surgical treatment of other diseases as obesity, chronic pancreatitis, alkaline gastritis, pancreatic pseudocyst, congenital or acquired biliary obstruction, and cases needing gastric or esophageal substitution<sup>1</sup>.

In childhood, RYA is performed mainly as a part of hepaticojejunostomy and portoenterostomy, for choledochal cyst (CC) and biliary atresia (BA), whereas other indications with oncologic, pancreatic, bariatric and traumatic origins are more frequent in adults. Since its introduction as an alternative to hand-sewn method; stapled gastrointestinal anastomosis has been widely studied for over 50 years, but mainly on patients of adult age with a diverse number of indications and anastomosis sites<sup>2-7</sup>.

As stapler use in RYA at pediatric age has not been focused before; the aim of this study is to evaluate and compare the outcomes of stapled and hand-sewn Roux-en Y intestinal anastomoses in childhood. There are studies indicating that performing the anastomosis with a stapler, as opposed to being done hand-sewn, contributes to the improvement of the operation time and other surgical results<sup>8-10</sup>. We also think that the use of stapler anastomosis will improve our surgical results. In addition, this study will contribute to the diversity of cases on the use of staplers in childhood gastrointestinal tract anastomoses, which are few in the literature.

## MATERIALS AND METHODS

At Cukurova University Faculty of Medicine Balcali Hospital, the records of the children who underwent Roux-en-Y intestinal anastomoses at the Department of Pediatric Surgery between December 2007 and December 2014 were reviewed.

The patients were evaluated in terms of age, performed surgical procedures, operation length, RYA technique, postoperative nasogastric (NG) drainage length, postoperative initial enteral feeding time, length of hospital stay and postoperative

cholangitis. Among the parameters to be compared, the continuous variable values were converted into categorical variables, by defining 2 categories for each, according to clinically relevant cutoff points: operation length ( $\leq 5$  hours,  $> 5$  hours), postoperative NG drainage length ( $\leq 72$  hours,  $> 72$  hours), postoperative initial feeding time ( $\leq 96$  hours,  $> 96$  hours), hospital stay length ( $\leq 7$ ,  $> 7$  days) and postoperative cholangitis (Yes, No). The data were compared according to the RYA technique used (stapled versus hand-sewn). The data were compared separately in biliary atresia and choledochus cysts groups.

All procedures performed in studies involved human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This study was approved by the Ethics Committee of Cukurova University (03.06.2022-123/5).

## Operative technique

The choice of the RYA technique (stapler or hand-sewn) was determined by preference of the senior surgeon. In all patients (CC and BA) laparotomy with intraoperative cholangiography composed the first phase of the operations. After excision of the CC or fibrotic tissues including bile duct remnants in BA, a retro-colic Roux-en-Y loop of jejunum was prepared with the length appropriate with the size of the patient. Then an end-to-side porto-enterostomy (for BA) or hepatico-jejunostomy (for CC) was performed with the same technique in all cases.



Figure 1. Transection of jejunum

## Stapled RYA

For the *initial transection of jejunum* at a level 15 – 20 cm distal to duodenum; the linear endoscopic stapler of 30/2.5 mm was used for newborns and infants, and 45/2.5 mm for older patients (Endo GIA, Auto Suture, Universal Stapler, Covidien, Mansfield, MA, USA) (Figure 1). As the next step, *aside-to-side (functional end-to-end) jejuno-jejunal stapled anastomosis* was performed 30 – 50 cm distal to the portoenterostomy level, using the linear endoscopic stapler of 30 or 45/2.5 mm.

*-Side to side stapled anastomosis:* This is an “anatomical side-to-side and functional end-to-end” anastomosis, which was described by Steichen in 1968<sup>11</sup>. The proximal end of the previously stapled-divided jejunum was fixed side to side with two seromuscular stitches along a 5 – 7 cm-long segment which is 30 – 50 cm distal to the Roux loop (Figure 2a). The stapler device was inserted into the lumens of those side-to-side-attached segments through their cautery-incised antimesenteric walls (Figure 2b). After making sure that the stapler held both antimesenteric walls (but nothing else), it was closed and fired (Figure 2c). A 3 – 4 cm-long side-to-side anastomosis was created (Figure 2d). Then, the stapler insertion points were closed with two-layer anastomoses. Further Lembert sutures were applied to bring the antimesenteric walls of the “Y” limbs of

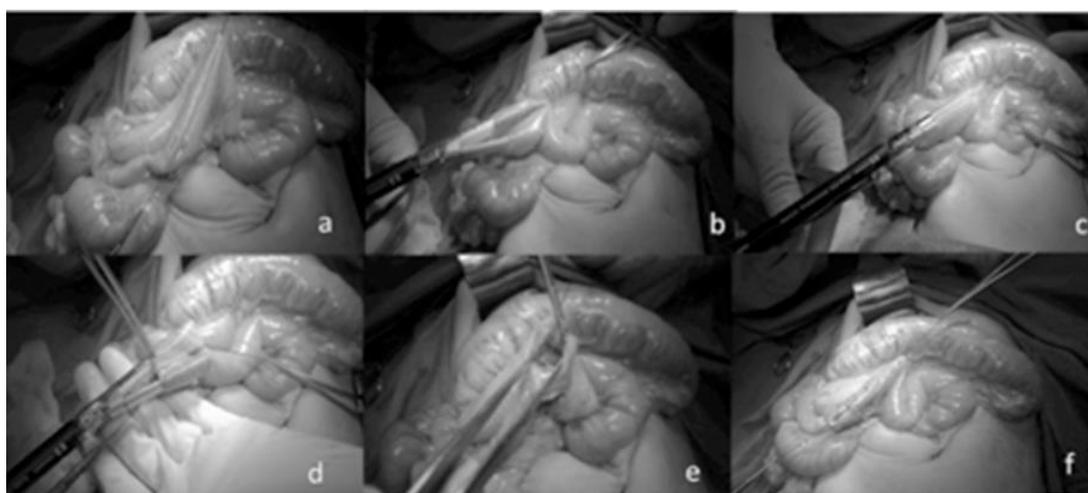
the segment 2 – 3 cm proximal to the anastomosis towards the portoenterostomy, in order to create anti-reflux mechanism by creating an acute angle between the Roux-en Y limbs (Figure 2e-f).

## Hand-sewn RYA

The standard hand technique was typically fashioned as two-layered anastomosis – inner continuous, outer interrupted – with absorbable sutures to close the jejunal ends after initial transection 15 – 20 cm distal to the duodeno-jejunal junction. Then a two-layered end-to-side hand-sewn anastomosis was performed to connect the Roux-en Y limbs, using absorbable suture materials (Figure 3).

## Statistical analysis

Non-parametric tests were chosen for continuous variables since the data were not distributed normally. Comparisons between groups were applied using the Mann-Whitney U test. The categorical variables between the groups were analyzed by using the Chi square test or Fisher's exact test. While evaluating risk factors, Odds Ratios (OR) were calculated. Results were presented as Median (min-max). “p” values less than 0.05 were considered statistically significant. Statistical analyses were performed using the statistical package IBM SPSS v 20.0<sup>12</sup>.



**Figure 2.** a; Side to side fixation of loops, b; Insertion of stapler device, c; Shooting the stapler, d; Opening the stapler, e; Checking the anastomosis, f; Lembert sutures creating anti-reflux mechanism.

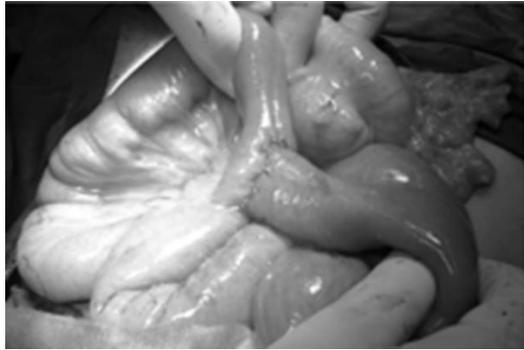


Figure 3. End-to-side hand-sewn anastomosis

## RESULTS

A total of 52 (22 male [M], 30 female [F]) patients were detected to have undergone RYA. Of those; 31(15 M, 16 F) had BA and 21 (7 M, 14 F) had CC. Stapled anastomosis (SA) technique was used in 25 patients and hand-sewn (HSA) technique was used in 27 patients. The SA group was composed of 16 BA

and 9 CC cases; whereas HSA group included 15 BA and 12 CC cases. The demographical and clinical features of the patient groups according to the operation techniques are shown in Table 1.

In both CC and BA groups, the differences between ages, sex distributions and body weights of the SA and HSA subgroups were statistically insignificant. Both in BA and CC cases; operations with SA were significantly shorter than the ones with HSA, with p values of 0.019 and 0.041, respectively. Among the BA cases; in the SA group, post-operative oral feeding was initiated significantly earlier than the HSA group ( $p=0.002$ ). Such a significant difference was not detected among the CC cases ( $p=0.464$ ). No post-operative cholangitis was encountered after CC excision, while 12 of the operated BA patients had cholangitis. Three (18.8% of the SA group of BA) of them had SA, the remaining 9 (60% of the HSA group of BA) had HSA. This difference between the SA and HSA groups of BA was statistically significant ( $p=0.023$ ). Post-operative NG drainage length and hospital stay length did not significantly differ between the groups.

Table 1. The demographical and clinical features of the patients, with diagnoses and operation techniques.

	Choledochal Cyst (n=21) Med (Min-Max)			Biliary Atresia (n=31) Med (Min-Max)		
	SA (n=9)	HSA (n=12)	p	SA (n=16)	HSA (n=15)	p
Sex (F/M)	4/5	10/2	0.159	10/6	6/9	0.289
Age at operation (Months)	6.0 (1.0-136.0)	45.0 (2.0-144.0)	0.422	3.0 (1.0-5.0)	3.0 (1.0-5.0)	0.711
Weight at operation (Kilograms)	10.0 (2.8-41.0)	13.7 (5.2-53.0)	0.422	4.8 (2.6-6.5)	4.6 (3.0-6.0)	0.338
Operation time (Minutes)	270 (220-360)	347.5 (235- 510)	<b>0.041</b>	282.5 (150-390)	350.0 (285-370)	<b>0.019</b>
Nasogastric drainage (Hours)	90(41-145)	117(65-166)	0.310	95.5(26-132)	100(72-168)	0.163
Initial feeding (Hours)	102 (50-164)	129 (72- 192)	0.464	95.5 (24-146)	123.0 (97-191)	<b>0.002</b>
Duration of hospital stay (Days)	7 (6-18)	9 (5- 27)	0.219	10.0 (4-17)	12.0 (7-28)	0.119
Postop. cholangitis	0	0	-	3 (18.8%)	9(60.0%)	<b>0.023</b>

In Table 2; the SA and the HSA subgroups of the CC and the BA groups were further divided according to the operation length (>5 hours, ≤5 hours), NG drainage length (>72 hours, ≤72 hours), post-operative feeding initiation times (>96 hours, ≤96 hours), hospital stay length (>7 days, ≤7 days), post-operative cholangitis history (yes, no). In those terms,

statistically no significant difference was detected between SA and HSA subgroups of the CC group. The BA group beared significant differences between its SA and HSA subgroups in Table 2: the HSA cases revealed a higher risk of operations longer than 5 hours ( $p=0.005$ ), a higher risk of longer NG drainage need than 72 hours ( $p=0.043$ ), a higher risk of feeding

initiation later than 96 hours ( $p=0.006$ ), a higher risk of hospital stay longer than 7 days ( $p=0.040$ ) and a

higher risk of having post-operative cholangitis ( $p=0.023$ ).

**Table 2. Evaluation of operation techniques as possible risk factors, in terms of some critical clinical variables**

		Choledochal Cyst (n=21) n (%)			Biliary Atresia (n=31) n (%)		
		SA	HSA	OR (%95 CI) p	SA	HSA	OR (%95 CI) p
Operation length	>5 hours	4 (44.4)	10 (83.3)	6.3 (0.8- 46.6) 0.159	6 (37.5)	13 (86.7)	10.8 (1.8-65.6) <b>0.005</b>
	≤5 hours	5 (55.6)	2 (16.7)		10 (62.5)	2 (13.3)	
NG tube removal time	>72 hours	8 (88.9)	11(91.7)	1.4 (0.1-25.4) 1.000	11(68.8)	15 (100.0)	6.8 (0.7-66.9) <b>0.043</b>
	≤72 hours	1(11.1)	1(8.3)		5 (31.2)	0 (0.0)	
Initial post-op. feeding	>96 hour	7 (77.8)	10 (83.3)	1.4 (0.2-12.7) 1.000	7 (43.8)	14 (93.3)	18.0 (1.9-171.9) <b>0.006</b>
	≤96 hour	2 (22.2)	2 (16.7)		9 (56.2)	1(6.7)	
Hospital stay length	>7 days	3 (33.3)	8 (66.7)	4.0 (0.6-25.0) 0.198	10 (62.5)	14 (93.3)	8.4 (1.0-81.1) <b>0.040</b>
	≤7 days	6 (66.7)	4 (33.3)		6 (37.5)	1(6.7)	
Postop. cholangitis	Yes	-	-	-	3 (18.8)	9 (60.0)	6.5 (1.3-33.1) <b>0.023</b>
	No	9 (100)	12 (100)		13(81.2)	6(40.0)	

## DISCUSSION

In parallel to increased availability of the appropriate tools and conditions, the minimally invasive procedures have been more widely applicable to newborns and infants. The endoscopic stapling devices, manufactured for such procedures, may have beneficial uses in open operations, too.

Through decades, with development and improvements of the stapling devices; stapled intestinal anastomosis has been a safe and globally accepted alternative to the traditional hand-sewn method. Numerous studies in the literature focused on the safety and the efficacy of stapled intestinal anastomoses and/or compared it with HSA in many terms; but very few of them focused solely on pediatric age group<sup>2</sup>.

One of those was Powell RW's study, in 1995; a series of 7 cases, which reported outcomes of the stapled "functional end-to-end (anatomic side-to-side)" anastomosis in neonates and infants. Although the series included only one case of RYA (for BA); with the remaining cases of necrotizing enterocolitis (NEC), ileal volvulus, mesenteric cyst, ileal atresia; it comprised an important cornerstone for safe stapler use in even premature newborns weighing less than 2 kg<sup>13</sup>.

In 2008, Wrighton et al studied the comparison of the stapled and hand-sewn intestinal anastomoses in infants younger than 1 year. With the largest reported series of the time including NEC, intestinal atresia, intestinal perforation and obstruction cases; the authors concluded that there was no significant difference in postoperative complications including obstruction, adhesions and anastomotic leak, but SA had yielded a significantly shorter operative time than HSA<sup>14</sup>. Our study supports them in CC and BA, with its significantly shorter operative times with stapled RYA.

In 2010, Simmons et al. evaluated the role of stapled intestinal anastomoses in neonates with the diagnosis included intestinal atresia, NEC and incarcerated inguinal hernia. Their remark of no difference in terms of postoperative complications was not new, but the suggestion of that study "to further investigate if SA leads to a shortening of time to initiate enteral feeding" has been attempted to be answered by our study<sup>15</sup>.

In 2013, the retrospective study by Kozlov et al. comparing SA with HSA performed on 44 (23 HSA, 21 SA) patients for neonatal intestinal problems alike with Wrighton et al's study, confirmed that SA in infants yielded shorter operative times, but detected no difference on times to achieve full enteral feeding and lengths of hospital stay. They also concluded that

the age and size of the patients were not the limiting factors for using gastrointestinal staplers<sup>16</sup>.

To our knowledge; except the only BA case, included in Powell's successful SA series, stapled RYA and its comparison with HSA method in pediatric age group has not been the primary focus of a study to date. Upon the basic knowledge provided by the studies mentioned above and more, our study is the first, to compare stapled and hand-sewn RYA in children.

Although bariatric surgery indications tend to invade adolescent age group by the increasing obesity prevalence; in childhood and especially infancy, CC and BA still comprise the most prominent indications of Roux-en-Y reconstruction which is a standard part of the surgical management of those diseases, to maintain biliary flow and enterohepatic circulation. Even though hepaticojejunostomy and portoenterostomy are well-defined surgical procedures, which are performed successfully worldwide by pediatric surgeons; the indefinite pursuit for better results integrates new tools and techniques, so surgery evolves with time.

The statistical indifference of the compared groups in terms of ages, weights; the comparison of HSA and SA of the same anatomic (jejunal) intestinal segments, between the cases of the same diagnosis can be thought as the reinforcing factors of the compared data, by limiting dependent variety. Absence of any primary intestinal pathology in any of the cases also limits the intrinsic factors interfering with the reliability of the comparison.

Our study confirms the previously well-studied time-saving advantage of SA over HSA, during RYA for BA and CC as well, along with the safety of stapler use in pediatric age, including the neonatal period. BA group of our study revealed earlier initial feeding and shorter hospital stay of SA cases, compared to the HSA cases.

Among the CC cases; although the hospital stay length, initial feeding time and post-operative cholangitis incidence values did not reveal a difference of statistical significance between the SA and HSA groups; that may be attributable to their small sample sizes.

The "functional end-to-end and anatomic side-to-side" SA yields a wider luminal cross-section than the end-to-side HSA in RYA; which may be a major contributor to lower complication incidences, faster

function gain with earlier feeding and hospital discharge.

We believe the acute angle we create between the converging Roux-n Y limbs in SA lowers the risk of reflux to the neo-bile duct; so in BA group, when SA was used, post-operative cholangitis was statistically significantly reduced. There are many studies concluded, increase in operation time causes increase in morbidity.<sup>17-19</sup> In our study, we reported that the use of staplers significantly shortens the operation time compared to hand-sewn anastomosis. The shortening of the operation time may be the reason of good results with the use of stapler anastomosis.

The retrospective nature of our study, with its moderately small sample sizes are the limiting aspects for the strength of the gained evidence; which could be overcome with well-randomized, prospective studies.

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