Extrahepatic versus Intrahepatic Hilar Control for Right Hepatectomy: An Updated Experience

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Key Words

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Abstract

Background: Inflow control prior to transection for right hepatectomy may be achieved either by dissection and ligation of the individual hilar structures outside of the liver (EHD) or by mass stapling of the inflow structures within the hepatic parenchyma. Our preference is for the anterior intra-hepatic approach (AIA) with mass stapling, in order to minimise the risk of inadvertent injury of the left-sided inflow and to preserve as much parenchyma as possible. In this paper, we present our experience over the last 10 years and compare it with results from the EHD technique. **Methods:** Data for a 10-year period from 2000 to 2010 were extracted retrospectively from a prospectively collected database. Results in each group were measured by a combination of technical and oncological outcomes. Groups were compared by way of descriptive statistics and differences tested for significance by appropriate statistical means. **Results:** 411 right hepatectomies were performed for colorectal metastases. Of these, 242 were by AIA and 169 by EHD. Both groups were well matched in demographic terms and according to disease burden, although more extended resections were performed in the EHD group. Operative duration (433 vs. 350

min), blood loss (420 vs. 348 ml) and incidence of bile leaks (4 vs. 2) were all lower in the AIA group. All other technical and oncological outcomes were equivalent. **Conclusion:** The AIA approach provides equivalent morbidity, mortality and oncological outcome to the EHD dissection technique and may confer the benefits of being safer and providing greater scope to preserve hepatic parenchyma.

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Introduction

The anterior intrahepatic approach (AIA) to right hepatectomy was first described by Tung and Quang in 1963 [1], who later popularised and promoted it as the ‘anterior trans-parenchymatous technique’ in 1965 [2]. This built upon the previous description of a posterior approach to control of the portal pedicle by way of hepatotomy – first described by Lin et al. in 1960 [3] and presented as a safer alternative to the classic approach of extra-hepatic hilar dissection (EHD), which had been described in 1952 by Lortat-Jacob et al. [4].

In our hands, the modern AIA consists of commencing parenchymal transection in the principle plane of the liver under inflow (Pringle) occlusion, using the cavitron ultrasonic surgical aspirator [5]. This first phase of transection is continued until the right main portal inflow or

first order anterior and posterior branches have been dissected, following which they are divided using an endoscopic linear cutting stapler of appropriate size. Transection is then completed with division of the right hepatic vein (again using an endoscopic stapler) outside of the liver parenchyma. The AIA presents the potential benefits of reducing operative time and minimises risk of inadvertent injury of the contralateral inflow structures during EHD, and has been greatly facilitated by the advent and development of stapling devices [6].

We have previously shown that the preferential, but selective use of the AIA to right hepatectomy is both technically feasible and at least as safe as the conventional approach of EHD [7]. Our preference has been to adopt the AIA wherever possible, with tumours lying close to the porta hepatis (<1–2 cm) being the only absolute contra-indication to this technique. We believe that this approach holds three advantages. The risk of iatrogenic injury of the left-sided structures is minimised, vascular inflow and biliary drainage of the future liver remnant is maximised, and the technique affords flexibility to safely deal with unexpected anomalies of intrahepatic portal anatomy.

With the expanding requirement for parenchymal-sparing resections as the result of both increased chemotherapy-associated hepato-toxicity and planned staged liver resection, we would advocate the AIA where possible and present an updated 10-year experience with this technique.

Materials and Methods

A retrospective case-controlled study of a prospectively collected database was performed. All patients undergoing right hepatectomy for colorectal liver metastases over a 10-year period between September 2000 and 2010 were included. The choice of operative technique was not randomised and reflected the surgeon's preference with a trend towards increased use of the AIA as the series progressed. Close proximity of tumour to the portal bifurcation was the only absolute indication for EHD in the more contemporary part of the series.

The preoperative and radiological selection of patients and a detailed description of operative and anaesthetic techniques have been described previously in detail [7–9].

Transection was performed using ultrasonic dissection (cavitron ultrasonic surgical aspirator) [5] under intermittent Pringle manoeuvre, generally involving 20 min of occlusion alternating with 5 min of reperfusion. All stapling procedures were performed using the Autosuture Endovascular Device (Covidien UK, Gosport, UK).

The primary outcome measures were mortality, morbidity, oncological margins, technical factors and duration of operation.

Statistical analysis was performed using SPSS version 15 (SPSS, Inc, Chicago, Ill., USA). Normality of distribution was tested using Kolmogorov-Smirnov test, with age being the only normally distributed continuous variable. We therefore utilised paired t test for age, Cochran's Q test for binary categorical variables and Wilcoxon's signed rank test for all continuous variables.

Results

Demographics

A total of 1,186 resections for colorectal liver metastases were performed over the study period, with 411 of these being right hepatectomy – comprising 34% of the total workload. 242 patients underwent the AIA, whilst classical EHD was performed in 169 cases.

Mean age at the time of surgery was 63 (range 29–85 years). Both groups were well matched for age, sex, ASA grade, the presence of background liver disease (table 1) and the interval between the cessation of chemotherapy and liver resection.

Disease Burden

The number, maximum size and hepatic distribution of metastases in both groups were broadly similar. Metastatic spread was confined to the right lobe in 77.2 and 74.7% of cases for AIA and EHD groups, respectively. There was no significant difference in the grade or stage of the primary colorectal lesion (table 2).

Extent of Resection

There were more extended resections performed in the EHD group (46 vs. 16%), reflecting the need to secure a clear margin with more centrally placed disease in this group. In both groups, the right hepatectomy was accompanied by a non-anatomical resection or wedge excision from the left side in a significant proportion of patients (table 2).

Duration of Operation and Hospital Stay

The duration of operation was significantly different, with a mean of 350 min in the AIA group versus 433 min in the EHD group ($p = 0.001$). There was no difference in hospital stay between the groups, with a median of 8 days in the AIA group (range 3–93) and 9 days in the EHD group (range 3–95).

Blood Loss

Total blood loss was significantly higher in the EHD group with a median of 420 ml (range 75–5,344) versus 348 ml (range 80–1,188) in the AIA group ($p < 0.001$).

Table 1. Background and details of study groups

	AIA (n = 242)	EHD (n = 169)	p value
Median age at operation, years	63 (29–85)	64 (30–84)	0.959
Sex			0.461
Male	143 (59.3)	107 (62.9)	
Female	99 (40.7)	62 (37.1)	
ASA grade			0.285
1	5 (2.1)	1 (0.6)	
2	191 (78.8)	127 (75.3)	
3	45 (18.7)	41 (24.1)	
4	1 (0.4)	0	
Background liver disease			0.769
None	167 (68.9)	110 (65.3)	
Fatty liver, steatosis	58 (24.1)	40 (23.5)	
Fibrosis	3 (1.2)	2 (1.2)	
Cirrhosis	1 (0.4)	1 (0.6)	
Sinusoidal dilatation	9 (3.7)	11 (6.7)	
Combination or other	4 (1.7)	5 (2.7)	
Median duration of operation, min	348 (120–475)	420 (150–475)	<0.001
Median intra-operative blood loss, ml	350 (80–1,450)	433 (75–5,344)	<0.001

Figures in parentheses indicate range or percentages.

Safety of AIA Technique

There were 3 incidences of staple gun misfiring in the AIA group, with one requiring suture ligation of the pedicle for intra-operative bleeding from the staple line. In 5 cases, bile leak at the staple line was identified intra-operatively, which required careful suturing with no further problems.

Morbidity

There was no statistical difference in pre- and post-operative liver function tests between the two approaches. Morbidity was similar between the groups, with the majority of complications being Clavien grades 1 and 2 [10] which were managed conservatively (table 3).

Bile Leaks

There were a total of six bile leaks; two were in the AIA and four were in the EHD group. There was one minor bile leak in each group, both of which settled promptly post-operatively. Two further leaks in the EHD group required ERCP and stenting to achieve resolution. A further patient in each group developed a leak refractory to stenting, and both required surgical reconstruction. Unfortunately, the patient in the EHD died subsequent to the reconstruction due to uncontrolled sepsis.

Mortality

The postoperative mortality for both groups was similar, with a 90-day mortality of 2.5% for the AIA group and 4.1% for the EHD group (table 3).

Oncological Outcome

We have reported disease burden based on the number and size of metastases reported by the histopathologist rather than those seen radiologically.

The R0 resection rate (defined as the absence of microscopic tumour at the margin) was 95% for the AIA group and 94% for EHD. The median follow-up time for all patients was 30 months (range 4–126). In that time, there was an equal incidence of recurrence of disease (both intra- and extra-hepatic) of 30 and 32% in the AIA and EHD groups, respectively. There was no difference in 1-, 3- and 5-year survival between the groups, with 5-year survival of 37.1% in the AIA group and 37.6% for EHD (table 3).

Discussion

This retrospective, non-randomised study is neither designed nor powered to prove superiority of one technique over another. We have, however, presented a substantial experience of a technique that, although first

Table 2. Details of primary, metastasis and operation

	AIA (n = 242)	EHD (n = 169)	p value
Median number of metastases	2 (1–20)	2 (2–20)	0.225
Distribution of metastases			
Right side only	187 (77.2)	126 (74.7)	
Both sides	55 (22.8)	41 (24.1)	
Caudate	0	2 (1.2)	
Median size of largest lesion, mm	40 (20–180)	40 (20–200)	
Histology of hepatectomy margin			
R0	230 (95)	159 (94)	
R1	12 (5)	10 (6)	
Dukes stage of primary			
A	7 (2.9)	9 (5.3)	
B	72 (29.9)	55 (32)	
C1	133 (55.2)	82 (48.2)	
C2	23 (9.5)	19 (11.2)	
Extent of resection			
Anatomical	157 (64.9)	73 (43.2)	
Anatomical + non-anatomical	46 (19.0)	18 (10.6)	
Extended anatomical + non-anatomical	39 (16.1)	78 (46.2)	

Figures in parentheses indicate range or percentages.

described more than 50 years ago, has failed to gain widespread popularity. We would suggest that for specifically selected cases where the tumour mass lies an adequate distance from the porta hepatis (>1 –2 cm), an anterior approach to controlling the main right portal pedicle, or indeed its branches (as dictated by the anatomy and the ‘thickness’ of the tissue of the main portal pedicle), within the liver substance can potentially avoid iatrogenic injury to the left-sided structures and may save operating time. However, use of this technique does involve a reliance on mechanical stapling devices, and these devices must be used correctly and appropriately. It has been our experience that attempting to staple tissue that is too bulky for the jaws of the device or attempting to compress too great a width of tissue within a single firing is fraught and often requires further remedial steps to oversee the pedicle which would otherwise bleed or leak bile. There were no long-term sequelae in patients who required reinforcement of the staple line, and it is our practice to apply a vascular clamp to the pedicle prior to removing a stapler that has felt subjectively to be ‘tight’ during the firing and to reinforce the staple line with a continuous suture prior to removing the clamp. Close attention to detail in the operation of the device, including its limitations, has been rewarded with fewer biliary complications when using the AIA

Table 3. Morbidity, mortality and recurrence

	AIA	EHD	p value
Post-operative complications (Clavien grade)			0.146
None	172 (71.1)	110 (65)	
Grade 1 and 2, conservative management	61 (25.2)	43 (25.4)	
Grade 3	2 (0.8)	7 (4)	
Grade 4a	4 (1.6)	5 (2.9)	
Grade 4b	3 (1.2)	4 (2.4)	
30-day mortality	4 (1.7)	5 (3)	0.786
90-day mortality	6 (2.5)	7 (4.1)	0.155
Liver recurrence to date			
No	169 (70)	116 (68.6)	
Yes	73 (30)	53 (31.4)	
1-year survival, %	90.5	93.5	
3-year survival, %	60.9	55.5	
5-year survival, %	37.1	37.6	

Figures in parentheses indicate percentages.

and none that could be directly attributed to use of the stapler itself. In both groups, the number of biliary complications fell well within the expected range compared to other series [11, 12].

The lower operating time and blood loss observed in the AIA group will be partly attributable to the time saved in avoiding an EHD, but also reflects the more difficult transection required for tumours located in close proximity to the porta and an increased requirement for additional non-anatomical resections within the EHD group. There is no doubt that patients undergoing resection by way of EHD had a more challenging tumour load and distribution, and certainly selection bias exists in those suitable for AIA.

Correct selection of the most appropriate technique for the individual tumour location and patient anatomy is clearly crucial. Nonetheless, where anatomical constraints allow, we would suggest that the AIA confers certain advantages over EHD with no evidence of drawback in terms of excess morbidity or mortality, and we would advocate its use wherever possible.

Conclusion

This work suggests that the AIA for right hepatectomy is as safe as EHD and can be used in the majority of patients undergoing right hepatectomy. It has an equivalent mortality and morbidity rate, and can possibly be performed more expeditiously and with advantages in terms of parenchymal preservation. The choice of procedure will depend to a large extent on a surgeon's preference and training, but we would suggest that the ability to perform this technique should be an essential component of the liver surgeon's repertoire.

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