

# Angiographic Assessment of the Right Hepatic Artery for Encasement by Hilar Cholangiocarcinoma: Comparison Between Antero-Posterior and Right Anterior Oblique Projections

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## Abstract

**Purpose:** To evaluate the usefulness of right anterior oblique (RAO) arteriography for evaluating encasement of the right hepatic artery (RHA) by hilar cholangiocarcinoma.

**Methods:** Celiac arteriography was performed in both the antero-posterior (AP) and RAO projection in ten patients with cholangiocarcinoma. The lengths of the arteries between the bifurcation of the anterior and posterior branch of the liver and the following points were measured: (a) the bifurcation of the left and right hepatic artery (AP-LR), (b) the bifurcation of the proper hepatic artery and the gastroduodenal artery (AP-PG). Additionally, image quality in investigating the invasion of the RHA was evaluated.

**Results:** On the AP images, the average lengths of AP-LR and AP-PG were  $24.5 \pm 5.1$  mm and  $30.0 \pm 4.9$  mm, respectively. On RAO images, the lengths were  $28.2 \pm 4.6$  mm and  $32.7 \pm 4.8$  mm, respectively. Every length was different between the two projections ( $p < 0.01$ ). In 6 of 10 patients with hilar cholangiocarcinoma, images in RAO projections were superior to AP images for evaluation of encasement.

**Conclusion:** We conclude that angiography obtained in the RAO projection yields images that are superior to those obtained in the conventional AP projection for assessment of RHA encasement.

**Key words:** Bile duct neoplasms, vascular invasion—Computed tomography—Angiography

Hilar cholangiocarcinoma has long been considered an incurable disease. Recently, however, surgical management of

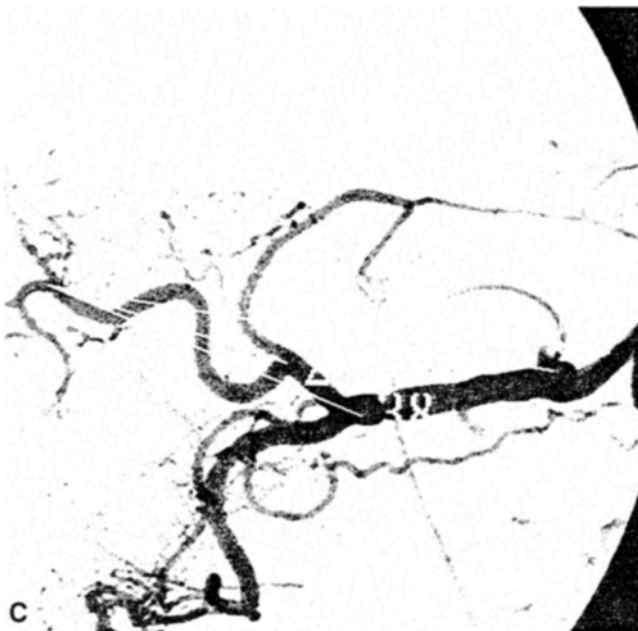
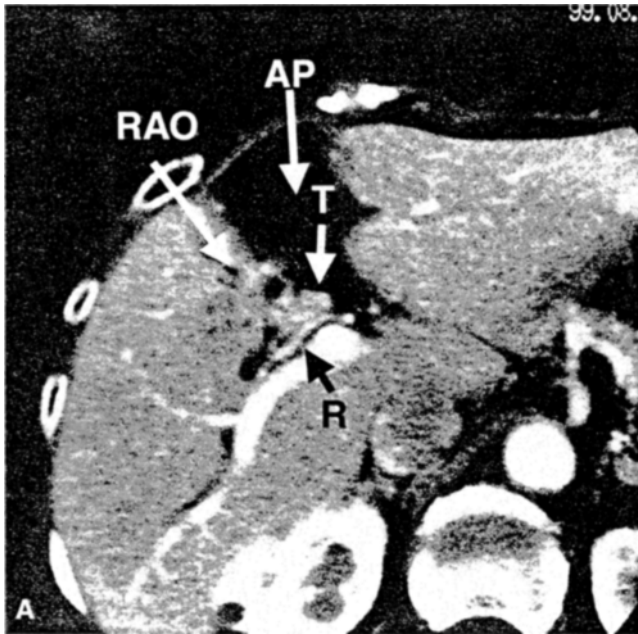
this disease has improved due to advances in diagnostic imaging and refinements in surgical techniques [1–4]. Anatomically, the right hepatic artery usually runs just behind the common hepatic bile duct. Once hilar bile duct carcinoma develops, the right hepatic artery (RHA) is easily invaded. It is important to evaluate whether the RHA has become involved by the tumor or not.

The purpose of this study was to compare the conventional antero-posterior (AP) projection hepatic arteriography with the right anterior oblique (RAO) projection for their ability to detect encasement of the RHA by cholangiocarcinoma.

## Materials and Methods

Between April and September 1999, ten patients [5 men, 5 women, aged 35–83 years (mean 68 years)] with hilar cholangiocarcinoma underwent staging hepatic arteriography. All patients underwent surgical resection within 2 weeks of angiography. All radiological studies were performed using a digital subtraction angiography (DSA) system (KXO-80C/DFP-2000A, Toshiba Medical Systems, Tokyo, Japan). Patients underwent this study in connection with preoperative staging arteriography. Informed consent was obtained from all ten patients before the procedure.

A 5 Fr catheter (Serecon catheter; Clinical Supply, Gifu, Japan) was inserted via the right transfemoral approach. After confirming the branching pattern of the celiac artery, a celiac arteriogram was performed in the AP projection using a 10- or 12-inch image intensifier at an imaging rate of 2 frames per second. Then, an arteriogram was performed in RAO projection. The x-ray tube was rotated to a position vertical to the craniocaudal axis. This oblique angle had been determined by a preliminary CT study where a 30° angle to the right of the midline (Fig. 1) was found to be the most orthogonal to the course of the RHA. Ioversol (Optiray; Mallinckrodt Medical, Montreal, Canada) (350 mg iodine per milliliter) at a



**Fig. 1.** A 78-year-old woman with hilar bile duct carcinoma. **A** Contrast-enhanced CT shows the right hepatic artery (R) running behind the tumor of the bile duct (T) from the left anterior side to the right posterior side. AP and RAO indicate the projected angle on antero-posterior and right anterior oblique images of arteriography. The RAO projection is more orthogonal to the running course of the right hepatic artery than is the AP projection. AP projection (**B**) and RAO projection (**C**) celiac arteriography. Numbers indicate the length of each line (mm). The lengths between the bifurcation of the anterior and posterior branch of the liver and the bifurcation of the left and right hepatic artery and the bifurcation of the proper hepatic artery and the gastroduodenal artery are longer on **C** than on **B**.

rate of 5–7 ml/sec for a total volume of 25–40 ml was injected by a power injector (Autoenhance A-50; Nemoto Kyorindo, Tokyo, Japan). In both AP and RAO images, the rate and volume of injected contrast medium were the same. The images were stored on an optical disk and selected images were printed on laser film. Printed images of both AP and RAO studies were evaluated simultaneously just after each examination.

In all ten patients, the length of the arterial segment between the bifurcation of the anterior and posterior branches of the hepatic artery and the following points were measured on both AP and RAO images: (a) the bifurcation of the left and right hepatic artery (AP-LR), (b) the bifurcation of the proper hepatic artery and the gastroduodenal artery (AP-PG) (Fig. 1). These lengths were electronically measured and shown on the display monitor of the DSA system. The mean and standard error were calculated. The Stu-

dent's *t*-test was used to compare the means of the two groups. Image quality enabling diagnosis of encasement of the RHA comparing both AP and RAO images was evaluated by two investigators (H.F., R.I.). Discrepancies were resolved by consensus.

## Results

On AP images, the lengths of AP-LR and AP-PG were  $24.5 \pm 5.1$  mm and  $30.0 \pm 4.9$  mm, respectively. Simultaneously, on RAO images, the lengths were  $28.2 \pm 4.6$  mm and  $32.7 \pm 4.8$  mm, respectively. Every projected length of artery was significantly different between AP and RAO projections ( $p < 0.01$ ). In 6 (60%) of 10 patients with hilar cholangiocarcinoma, the RAO image was superior to the AP

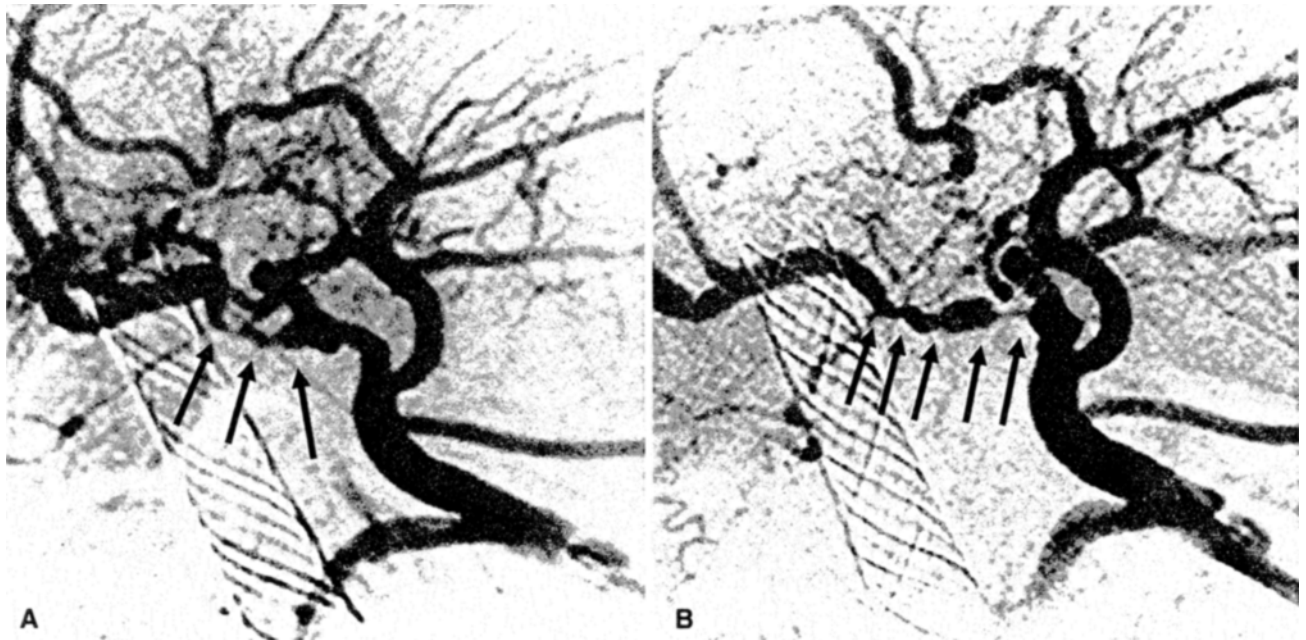


Fig. 2. A 60-year-old man with hilar cholangiocarcinoma. **A** AP projection arteriogram. **B** RAO projection arteriogram. Encasement of the right hepatic artery (arrows) is clearly demonstrated on **B**.

Table 1. Summary of ten patients with hilar cholangiocarcinoma

Patient no.	Age	Sex	AP-LR (mm)		AP-PG (mm)		Superiority to evaluate RHA
			AP	RAO	AP	RAO	
1	64	M	21	26	32	35	RAO
2	66	M	24	27	33	32	Equivalent
3	78	F	33	38	33	38	RAO
4	66	F	21	27	27	27	Equivalent
5	83	M	25	28	28	31	RAO
6	65	F	20	22	30	30	Equivalent
7	82	M	21	25	20	25	RAO
8	35	F	34	34	38	39	Equivalent
9	78	F	25	28	32	38	RAO
10	60	M	21	27	27	32	RAO

AP-LR = length between the bifurcation of the anterior and posterior branch of the liver and the bifurcation of the left and right hepatic artery; AP-PG = length between the bifurcation of the anterior and posterior branch of the liver and the bifurcation of the proper hepatic artery and the gastroduodenal artery; AP = antero-posterior projection; RAO = right anterior oblique projection; RHA = right hepatic artery

image for evaluating the invasion of the RHA because the RHA could be viewed in its full length (Table 1, Figs. 2, 3). In the remaining four patients, both images were equally diagnostic.

Using these images, three patients with invasion of the RHA were diagnosed preoperatively (Figs. 2, 3). The findings were confirmed at surgery and a right lobectomy was performed. Histologically, tumor had invaded the media in two and the adventitia in one. In the other seven patients, no evidence of arterial invasion was shown by arteriography, nor found in surgery. There were no false positive or false negative arteriograms.

## Discussion

Usually, the proper hepatic artery runs to the left of the extrahepatic bile duct and divides the RHA across the common hepatic duct. When a cancer occurs in this area, the RHA easily becomes involved. Evaluation of the RHA is crucial, not only for the staging but also for surgical assessment of the hilar cholangiocarcinoma when vascular reconstruction is contemplated.

Hepatic arteriography is an accurate and well-established method of demonstrating the anatomy and pathology of hepatic arteries. However, some lesions are missed due to the x-ray beam being tangential to the course of the vessel, the overlapping of multiple arteries, or the eccentricity of the lesion on conventional AP projected images [5]. As shown by CT (Fig. 1), the right hepatic artery usually runs behind the bile duct from the left anterior side to the right posterior side. On AP projected images, the x-ray beam is tangential to the course of the RHA. To make the x-ray beam more orthogonal to the RHA, we tried an RAO projection.

Comparing the lengths of AP-LR and AP-PG on AP and RAO images, both lengths were longer on RAO images than on AP images. Furthermore, in 60% of patients with hilar bile duct carcinoma, RAO images were superior to AP images in evaluating the invasion of the RHA. In one case the invasion of the RHA was correctly diagnosed by the RAO image alone. The advantage of RAO imaging is that the RHA can be viewed lengthwise along its course because the x-ray beam is more orthogonal than on AP images. Thus, this view clearly demonstrates the irregular appearance of invasion by tumors. Although the oblique angle was fixed in this study, it should be properly selected according to the

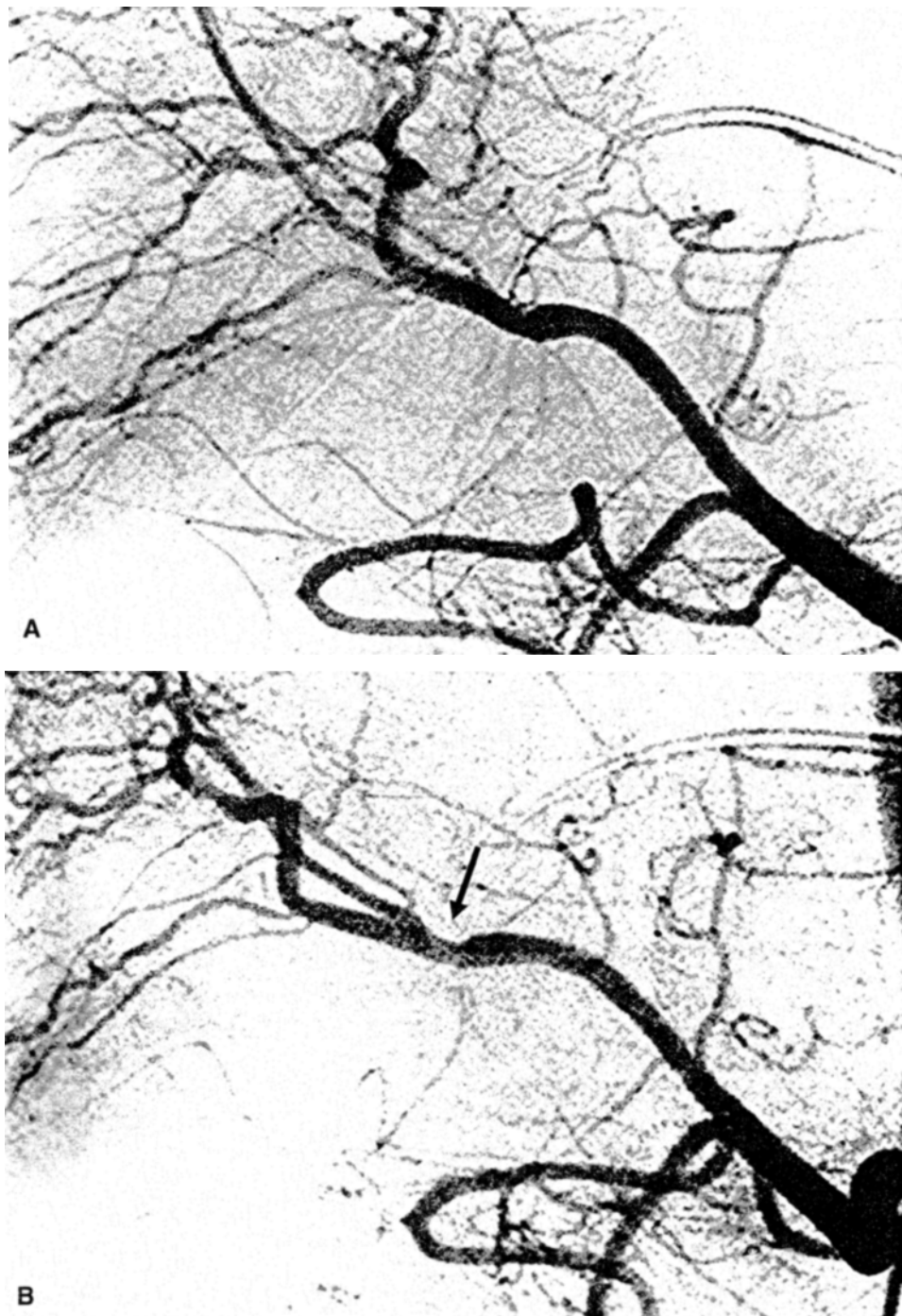


Fig. 3. A 60-year-old man with hilar cholangiocarcinoma. **A** AP projection arteriogram. **B** RAO projection arteriogram. Encasement of the right hepatic artery (arrow) is clearly demonstrated on **B**.

course of the objective vessel. Conventional transaxial CT and magnetic resonance (MR) images may be useful for this selection.

Spiral CT angiography [6] and MR angiography [7] are minimally invasive techniques for evaluating abdominal vasculature from any arbitrary angle. Moreover, using multidetector CT, the pure arterial phase obtained can clarify the involvement of tumor in the vessels. It is expected that these techniques will replace conventional angiography for the purpose of diagnosis in the near future. However, favorable results combined with a careful approach, as in this study,

are also useful to determine the optimal projected images for diagnosing the crucial points of concern.

In conclusion, the RAO projected image of celiac arteriography is more useful for the evaluation of the RHA than the AP projected image, because the x-ray beam is more orthogonal to the course of the artery. This technique contributes to the staging and surgical assessment of hilar biliary disease even when vascular reconstruction is contemplated.

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