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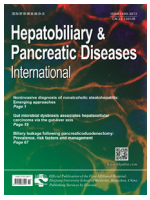

Letter to the Editor

Computed tomographic angiography for diagnosis of post-pancreatoduodenectomy hemorrhage ☆

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To the Editor:

Even in high volume specialist hepato-pancreato-biliary surgery centres, hemorrhage after pancreatoduodenectomy remains a feared and potentially lethal complication [1] and an important cause of postoperative morbidity and mortality [2].

Whilst early hemorrhage after pancreatoduodenectomy is typically managed by re-operation, detection and treatment of bleeding later in the postoperative course can be problematic. Patients who are hemodynamically unstable with evidence of brisk bleeding are usually treated by urgent re-operation. However, not all bleeding episodes present in such a dramatic fashion. The "sentinel bleed" – a harbinger of major hemorrhage–represents a clinical opportunity for detection and treatment [3]. Traditionally, patients who presented with luminal bleeding episodes with hematemesis or melena underwent fibre optic endoscopy as first-line investigation whereas patients presenting with a bleed into surgical drains would have undergone selective mesenteric angiography [4]. The advent of computed tomographic angiography (CT angiography: arterial phase contrast CT preceded by non-contrast run) has influenced these algorithms [5]. CT angiography can provide evidence of arterial extravasation of blood and can also demonstrate false aneurysm formation. Although CT angiography lacks a therapeutic option, it is increasingly used as the first line test for investigation of post-pancreatoduodenectomy hemorrhage. We report individuals with post-pancreatoduodenectomy hemorrhage investigated by CT angiography in the regional hepato-pancreato-biliary service of the Manchester Royal Infirmary, Manchester, UK. A consecutive series of 176 patients underwent pancreatoduodenectomy during October 2014 and February 2017. All postoperative complications were prospectively recorded in a complications database. Patients were included in this study if they had clinical evidence of hemorrhage at any point after operation until the 90th postoperative day (including patients who were discharged and readmitted). Demographic data, operative detail, postoperative course and information on final histological diagnosis were collected. Clinical evidence of bleeding was considered when a patient met one or more of the following criteria: hemodynamic instability, drop of hemoglobin ≥ 2 g/dL, fresh blood in abdominal drain, melena or hematemesis. No patients in this study underwent neoadjuvant chemotherapy. All patients were given subcutaneous octreotide starting immediately postoperatively for a variable duration determined by whether or not there was a post-operative pancreatic fistula. Drain fluid was sampled for amylase content on the third postoperative day. Low molecular weight heparin was used for thromboprophylaxis unless there was evidence of hemorrhage.

Post-pancreatectomy hemorrhage and pancreatic fistula were defined as described by the International Study Group of Pancreatic Surgery (ISGPS) [6,7]. Scale variables were expressed as median (range) and categorical parameters as absolute count and percentage. Of the 173 consecutive patients who underwent pancreatoduodenectomy, 20 patients underwent CT angiography to investigate clinical signs and symptoms of post-pancreatoduodenectomy hemorrhage. The median age of these 20 patients was 66 years (range 46–79) and 17 (85%) were male. Fifteen patients (75%) had undergone classical pancreatoduodenectomy with 5 (25%) undergoing the pylorus-preserving variant. Two patients (10%) had undergone portal vein resection with primary reconstruction without the use of grafts. Final histological diagnosis was malignant disease in 17 patients (85%) with three patients undergoing surgery for intraductal papillary mucinous neoplasm (IPMN). Postoperative pancreatic fistula had been diagnosed in 10 patients (50%). Individual patient-level data on type of operation, grade of fistula, final diagnosis, in-patient stay and outcome are presented in Table 1. The clinical presentation of post-pancreatoduodenectomy hemorrhage can be seen in Table 2. Bleeding into drains was the most frequent presentation occurring in 8 patients (40%). Five patients (25%) presented with either hematemesis, vomiting of altered blood or melena. In the cohort as a whole, the median day of presentation with post-pancreatoduodenectomy hemorrhage was the 6th post-operative day with a range of 2 to 36 days. Median fall in hemoglobin during the day of hemorrhage was 4.5 g/dL. Sixteen patients (80%) had blood transfusion. On ISGPS criteria, 12

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Table 1
Demographics, disease profile and outcome of patients with PPH.

Case	Age (yr)	Sex	Operation	Histological diagnosis	Pancreatic fistula	Hospital stay (d)	Outcome
1	60	M	Classic PD	Main duct IPMN	Biochemical leak	15	Survived
2	63	M	PPPD	Well differentiated PNET	–	6	Died
3	46	M	Classic PD	PDAC	–	14	Survived
4	70	M	PPPD	Distal bile duct cholangiocarcinoma	–	15	Survived
5	47	F	Classic PD	GIST	Biochemical leak	15	Survived
6	79	M	Classic PD	Distal bile duct cholangiocarcinoma	–	13	Survived
7	78	M	Classic PD	Distal bile duct cholangiocarcinoma	–	18	Survived
8	66	M	PPPD	PDAC	–	13	Survived
9	59	M	PPPD	PDAC	Biochemical leak	10	Survived
10	69	M	Classic PD	Ampullary adenocarcinoma	Biochemical leak	16	Survived
11	65	M	PPPD	Distal bile duct cholangiocarcinoma	Grade B	14	Survived
12	67	M	Classic PD	Well differentiated PNET	Biochemical leak	35	Survived
13	75	M	Classic PD	Branch duct IPMN	Grade C	33	Survived
14	72	M	Classic PD	Distal bile duct cholangiocarcinoma	–	15	Survived
15	78	F	Classic PD + PV resection	IPMN	–	30	Died
16	61	M	Classic PD	Ampullary adenocarcinoma	Biochemical leak	12	Survived
17	46	M	Classic PD	Duodenal adenocarcinoma	Grade C	7	Died
18	69	M	Classic PD	Ampullary adenocarcinoma	–	12	Survived
19	63	M	Classic PD + PV resection	Distal bile duct cholangiocarcinoma	–	11	Survived
20	74	F	Classic PD	Duodenal adenocarcinoma	Biochemical leak	12	Survived

M: male; F: female; PPH: post-pancreatectomy hemorrhage; PD: pancreatoduodenectomy; IPMN: intraductal papillary mucinous neoplasm; PPPD: pylorus-preserving pancreatoduodenectomy; PNET: pancreatic neuro-endocrine tumour; PDAC: pancreatic ductal adenocarcinoma; GIST: gastro-intestinal stromal tumour; PV: portal vein.

Table 2
Presentation, grading and management of post-pancreatoduodenectomy hemorrhage.

Case	Grade of PPH	Timing of bleeding (postoperative day)	Clinical features	Hb drop (g/dL)	Intervention
1	C	25	Melena, fast AF, hemodynamic instability	8.4	Transfusion
2	C	2	Hemodynamic instability	5.4	Transfusion
3	B	6	Coffee ground vomiting, Hb drop	5.2	Transfusion
4	B	2	Fresh red blood in the drain	4.4	Transfusion
5	B	19	Fresh red blood in the drain	4.5	Transfusion
6	B	11	Hb drop	2.0	Transfusion
7	C	4	Fresh red blood in the drain, hemodynamic instability	4.3	Transfusion
8	B	7	Blood in the drain	4.2	Transfusion
9	B	4	Fresh red blood in the drain	3.3	Transfusion
10	C	14	Hb drop, hemodynamic instability	6.7	Transfusion
11	B	5	Fresh red blood in the drain	4.5	Angiography + embolization
12	B	2	Hematemesis. Hemodynamic instability	5.7	Transfusion
13	B	36	Fresh red blood in the drain	7.9	None
14	C	5	Hemodynamic instability	4.1	Transfusion
15	C	15	Melena, hemodynamic instability	4.1	Angiography + embolization + transfusion
16	B	3	Fresh red blood in the drain	4.9	Transfusion
17	C	2	Hemodynamic instability	2.9	Reoperation
18	C	9	Melena, hematemesis	5.6	Endoscopy + transfusion
19	B	8	Hb drop	3.5	None
20	B	6	Hemodynamic instability	4.5	Transfusion

PPH: post-pancreatectomy hemorrhage; Hb: hemoglobin; AF: atrial fibrillation.

patients (60%) had Grade B hemorrhage and 8 (40%) were categorized as grade C. Of the 20 patients undergoing CT angiography none of the scans showed either active extravasation or pseudoaneurysm. There were however radiological findings of recent prior hemorrhage in 6 patients: 5 had hemoperitoneum and 1 had blood in the stomach. Endoscopic, angiographic or surgical interventions for post-pancreatoduodenectomy hemorrhage were required in 4 patients (1 with post-pancreatectomy hemorrhage grade B and 3 with grade C). Two patients underwent angiographic embolization, 1 underwent therapeutic fibre optic gastroscopy with injection of adrenaline and application of clips to a suspected bleeding site. One patient underwent re-operation with under-running of a venous tributary of the superior mesenteric vein. Median hospital stay in this group was 15 days (range 6–35). There were 3 in-hospital deaths (Table 1).

Our study is thought to be the first to specifically assess the role of CT angiography for the diagnosis of post-pancreatoduodenectomy hemorrhage. The key finding is that although 20 patients were investigated for suspected post-pancreatoduodenectomy hemorrhage, positive findings were present in only 6 patients (30%). This incidence of post-pancreatoduodenectomy hemorrhage in this series is similar to that reported in other contemporary series [8]. Of patients with post-pancreatoduodenectomy hemorrhage, 50% had a biochemically confirmed pancreatic anastomotic leak supporting the clinical association between post-operative pancreatic fistula and hemorrhage [8]. Clearly, the findings of this report should be validated in separate cohorts of patients undergoing pancreatoduodenectomy before incorporation into management algorithms but the ready availability of CT angiography and its value in assessing other non-hemorrhagic complications (such as postoperative abscess) support CT angiography as the first line diagnostic test in patients with post-pancreatoduodenectomy hemorrhage who are sufficiently stable to undergo radiological imaging.

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Contributors

SAK proposed the study. PM performed the research and analyzed the data. BM collected the data and undertook statistical analyses. NV undertook the research and reviewed all CT scans. SAJ undertook the research. JS supervised the study and analysis. All authors contributed to the design and interpretation of the study and to further drafts. SAK is the guarantor.

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Ethical approval

The study was regarded as an audit by the Manchester University Foundation Trust's Research and Development team and registered with the Audit department (Audit number 7132; March 7, 2017).

Competing interest

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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