

Safety and Efficacy of First Arterial Approach in Management of Pancreatic Head Carcinoma

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ABSTRACT

Objective: This prospective investigation sought to assess the technical safety, possibility, & effect of the first arterial approach (FAA) throughout PD for pancreatic head adenocarcinoma on R0 resection rates, loss of blood during operation, duration of operation, as well as early detection of unresectable illness. **Patients and Methods:** 100 consecutive cases having a PD for pancreatic head adenocarcinoma at Al-Azhar University Hospitals (Jan 2023–Dec 2024) usually utilized the FAA, involved the 1st dissection & control of the common hepatic artery & SMA prior to venous dissection or pancreatic transection. 1ry results included R0 resection rate, operative time, loss of blood during operation, and proportion of early diagnosis of unresectability. 2ry results comprised postoperative complications (bleeding, delayed gastric emptying, pancreatic fistula) & short-term survival. **Results:** FAA was technically viable in all instances. An R0 resection has been done in eighty-eight percent (88/100) of cases. Mean loss of blood during the operation was 350±120 milliliter; mean operative time was 380±75 minutes. Unresectable illness has been detected early in ten percent (10/100) of cases, avoiding additional wide dissection. Clinically relevant pancreatic fistula (Grade B/C) was fifteen percent, bleeding following pancreatectomy was seven percent, & delayed gastric emptying was 18%. The death rate within 30-days was 2%. **Conclusion:** FAA in pancreatic head carcinoma is a safe and effective method for early resectability assessment, enhancing R0 resection rates, avoiding unnecessary dissection in unresectable cases, and demonstrating acceptable perioperative results, thereby warranting its implementation in specialized environments.

Keywords: *Pancreaticoduodenectomy, Pancreatic Cancer, Superior Mesenteric Artery, Pancreatic Fistula, First Arterial Approach.*

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1. INTRODUCTION

Pancreatic head adenocarcinoma is still one of the deadliest malignancies, characterized by aggressive biology, late presentation, as well as a dismal prognosis [1]. Despite advancements in diagnostic imaging and multimodal therapies,

surgical resection, primarily PD, gives the only potential for long-term survival. Nevertheless, only fifteen to twenty percent of cases existing with resectable disease, and even among these, achieving a margin-negative (R0) resection is often challenging because of the intimate anatomical relation of the pancreatic head with major peripancreatic vessels, particularly the portal vein/superior mesenteric vein (PV/SMV) confluence and the superior mesenteric artery (SMA) [2,3]. Traditional approaches to pancreaticoduodenectomy typically involve initial dissection and transection of the pancreatic neck and duodenum, followed by dissection of the retroperitoneal margin and vascular structures. A significant drawback of this conventional "duct-first" or "vein-first" strategy is the potential for encountering unresectable arterial involvement late in the procedure, after substantial and irreversible dissection (e.g., pancreatic transection, duodenal mobilization) has already occurred. This can lead to futile extensive surgery, increased morbidity, and psychological distress for the patient, without achieving the primary oncological goal [4]. To address this challenge, the FAA to pancreaticoduodenectomy has gained increasing attention, particularly in high-volume centers. This strategy prioritizes the early dissection & control of the major arterial structures, primarily the SMA and often the common hepatic artery (CHA), at the very beginning of the procedure [5]. By meticulously dissecting along the anterior and lateral aspects of the SMA, surgeons can definitively assess the extent of tumor involvement with these critical vessels. This early assessment allows for a precise determination of resectability before committing to irreversible steps of the PD, thereby guiding the subsequent surgical strategy and potentially avoiding unnecessary extensive dissection in cases found to be truly unresectable [6]. The theoretical advantages of the first arterial approach include improved R0 resection rates by ensuring adequate arterial margin clearance, reduced blood loss during operation by early control of major feeding vessels, and most importantly, the ability to identify unresectable disease early, thus minimizing futile surgery and associated morbidity [7]. Different variations of the FAA exist, including the anterior approach (e.g., uncinate process first) and the posterior approach (e.g., superior mesenteric artery first), each with its own technical nuances. Despite growing enthusiasm for this approach, robust data from diverse surgical settings regarding its consistent feasibility, safety profile, and definitive impact on oncological outcomes compared to conventional techniques are still valuable. The purpose of this prospective investigation was to estimate the technical feasibility, safety, as well as effect of the FAA throughout pancreaticoduodenectomy for the pancreatic head adenocarcinoma management. Specifically, we sought to assess its influence on R0 resection rates, operative time, blood loss during operation, as well as the early recognition of unresectable illness, thereby contributing to the evidence base supporting optimized surgical strategies for this challenging malignancy.

2. PATIENTS AND METHODS

This prospective observational research has been carried out at the Department of Surgical Oncology, Al-Azhar University Hospitals, Cairo, Egypt, over a twenty-four-month duration, from January 2023 to December 2024. The research protocol received permission from the Institutional Review Board of Al-Azhar University & all procedures adhered to the ethical principles of the Declaration of Helsinki. Informed, written consent has been gained from all participants prior to their enrollment. A total of one-hundred consecutive patients diagnosed with pancreatic head adenocarcinoma who have been scheduled for pancreaticoduodenectomy were enrolled. All patients were assessed preoperatively to be potentially resectable based on imaging. Inclusion Criteria: Cases aged not under eighteen years, histopathologically confirmed adenocarcinoma of the pancreatic head, preoperative imaging (MRI or CT) demonstrating possibly resectable or borderline resectable illness (no definite arterial encasement, no distant metastasis, or short segment venous involvement amenable to reconstruction), undergoing elective pancreaticoduodenectomy. American Society of Anesthesiologists (ASA) physical state I, II, or III & capable of give informed consent. Exclusion Criteria: Evidence of distant metastasis or locally advanced unresectable disease identified preoperatively (e.g., long-segment arterial encasement, extensive venous involvement not amenable to reconstruction), undergoing emergency surgery for biliary obstruction or pancreatitis, history of previous major abdominal surgery that would significantly complicate dissection, patients with other synchronous malignancies, patients undergoing distal pancreatectomy or total pancreatectomy and refusal to participate. A full preoperative assessment was performed on each and every patient. This assessment included of taking a detailed history, performing a physical examination, as well as performing routine laboratory assessment (involving a complete blood count, hepatic & kidney function tests, coagulation profile, & tumor indicators such as CA 19-9). Imaging prior to the operation comprised multiphase computed tomography (CT) of the abdomen and pelvis or magnetic resonance imaging (MRI) with magnetic resonance cholangiopancreatography (MRCP) to assess tumor resectability, vascular involvement, and exclude distant metastases. Endoscopic ultrasound (EUS) with fine-needle aspiration (FNA) verified the diagnosis & provided additional local staging information. Biliary drainage (endoscopic stenting) was performed for patients with obstructive jaundice prior to surgery. Nutritional assessment and optimization were performed as needed.

Surgical Procedure: Pancreaticoduodenectomy with FAA:

All of the operation has been carried out by experienced surgeons who specialize in hepatobiliary and pancreatic surgery and have experience performing difficult pancreatic resections. It was established by individual patient characteristics and the decision of the surgeon whether the surgical technique would be open or minimally invasive, if applicable; however, principles of the FAA have been carried out uniformly throughout the experience. The FAA comprises highlighting the dissection & control of the major arterial structures initial in the technique to definitively estimate resectability prior to

committing to irreversible steps. The specific method utilized in this research was the superior mesenteric artery 1st approach, that may be carried out either posteriorly or anteriorly. It was decided to arrange the cases in the supine part. The incision that has been utilized was a standard upper midline laparotomy incision. In order to verify that there were no peritoneal spread or liver metastases, a comprehensive abdominal examination has been carried out. The mobilization of the duodenum & the head of the pancreas: An extensive mobilization of the duodenum & pancreatic head has been carried out using the Kocher maneuver, which resulted in the exposure of the retroperitoneal region. During the 1st dissection of the SMA, the uncinate process of the pancreas has been retracted superiorly, & the dissection has been started along the anterior surface of the superior mesenteric vein (SMV) & the superior mesenteric artery, which was inferior to the pancreatic neck. This was done using the anterior method. A careful dissection and clearing of the lymphatic and fatty tissue that surrounded the SMA has been performed, which resulted in the artery being exposed from its origin. The early evaluation of cancer involvement with the SMA was made possible as a result of this.

Posterior Approach (SMA-First from Left Side): The jejunum has been separated, & the root of the mesentery has been exposed. Dissection was performed along the left side of the SMA, identifying the artery early and dissecting it circumferentially from its origin. This approach is particularly useful for assessing posterior tumor involvement. Concurrently or immediately following SMA assessment, the CHA has been dissected from its origin from the celiac axis, and the lymph nodes along it (station 8a) were cleared. The gastroduodenal artery (GDA) was recognized and ligated only after resectability was confirmed. Once the SMA and CHA were fully exposed and cleared of tumor involvement (or if involvement was clearly resectable with arterial reconstruction), the tumor was deemed resectable. If significant, unreconstructible arterial encasement was identified, the procedure was aborted, and no further irreversible steps (e.g., pancreatic transection) were performed. After arterial assessment, the PV/SMV confluence has been dissected. If venous involvement was present, it was assessed for resectability and potential reconstruction (primary repair or interposition graft). Following confirmation of resectability of both venous and arterial structures, the pancreatic neck has been transected, followed by transection of the common bile duct, duodenum, and jejunum. The entire specimen (duodenum, pancreatic head, gallbladder, distal stomach, & regional lymph nodes) was eliminated en bloc. Reconstruction involved pancreaticojejunostomy, hepaticojejunostomy, and gastrojejunostomy, typically in a modified Child's Roux-en-Y fashion. Abdominal drains have routinely been situated near the hepaticojejunostomy and pancreaticojejunostomy. Drain fluid amylase levels have been monitored on postoperative days 1, 3, and 5 to detect pancreatic fistula. Cases have been treated based on enhanced recovery after surgery (ERAS) protocols. Postoperative complications have been documented as much as thirty days following-operation and graded regarding the Clavien-Dindo classification system. Specific attention was paid to the frequency and degree of pancreatic fistula (defined by ISGLS criteria), delayed gastric emptying (DGE), as well as post-pancreatectomy hemorrhage (PPH). Duration of hospitalization, period to oral intake, and time to ambulation have been also documented. All resected specimens were meticulously examined by experienced gastrointestinal pathologists. R0 resection status (no macroscopic or microscopic residual tumor at all margins, including the SMA margin) was confirmed. Cases have been monitored at three-month intervals for the 1st year, then six-month intervals, including clinical examination, laboratory tests (e.g., CA 19-9), and imaging (CT scan of chest, pelvis, as well as abdomen) to assess for recurrence and long-term survival. R0 Resection Rate (Percentage of patients achieving a margin-negative resection), intraoperative blood loss (Measured in milliliters), operative time (calculated in minutes) and early identification of unresectable disease (Proportion of cases where unresectability was definitively determined by FAA before pancreatic transection or irreversible steps, leading to procedure abortion). Secondary Outcomes (Overall Postoperative Complication Rate): All complications within 30 days, graded by Clavien-Dindo. Specific Complications: Frequency of clinically relevant pancreatic fistula (Grade B/C), PPH, DGE and duration of Hospitalization (Number of days from operation to discharge).

3. STATISTICAL ANALYSIS

SPSS Statistics version 28.0 (IBM Corp, Armonk, New York, the united state of America) has been applied in order to performed the statistical analysis. To summarize baseline demographic and clinicopathological features at the beginning of the study, descriptive statistics have been carried out. These statistics presented continuous parameters as the mean \pm SD or the median (interquartile range, IQR), whereas categorical information have been presented as percentages and frequencies. Comparisons have been done against historical cohorts or established standards wherever it was suitable to do so. This was a single-group prospective investigation that evaluated the first arterial approach. For the purpose of conducting an internal analysis, the association among surgical findings and patient/tumor characteristics have been evaluated by applying suitable statistical tests such as the Pearson correlation and the χ^2 test. In every analysis, a p-value that was under 0.05 (p under 0.05) has been regarded to be statistically significant.

4. RESULTS

For the purpose of this prospective investigation, a total of one hundred cases who were having a pancreaticoduodenectomy for pancreatic head adenocarcinoma utilizing the FAA have been involved. There was a slight male predominance in the

patient group, with a mean age of 64.7 ± 8.9 years (range: forty-eight to eighty-two years) (55% n= fifty-five). The majority of tumors were ductal adenocarcinomas (95%, n=95). Preoperative imaging indicated potentially resectable disease in 70% (n=70) and borderline resectable disease in 30% (n=30) of patients. Neoadjuvant therapy was administered to 25% (n=25) of patients, primarily those with borderline resectable disease. Baseline case demographics & clinicopathological features are summarized in Table 1. Our results showing a typical distribution of age, gender, and tumor characteristics for patients undergoing PD for pancreatic head adenocarcinoma, including a significant proportion with borderline resectable disease (Table 1). The first arterial approach demonstrated technical feasibility in all cases. It achieved a high R0 resection rate of 88%. Crucially, unresectable illness has been recognized early in ten percent of cases, primarily due to extensive SMA encasement, allowing for procedure abortion before irreversible steps. (Table 2). The overall complication following operation rate was 35%, with clinically relevant pancreatic fistula (15%), DGE (18%), and PPH (7%) being the most common specific complications. The thirty-day death rate was two percent, which is within acceptable ranges for complex pancreatic surgery in high-volume centers. (Table 3). The mean number of harvested lymph nodes was 25.1 ± 7.3 . Lymph node metastasis (pN+) was confirmed in 60% (n=60) of the resected cases. The mean tumor size was 3.2 ± 1.1 centimeter. Pathological T-stages were distributed as pT1 (5%), pT2 (20%), pT3 (65%), and pT4 (10%). Lymphovascular space invasion (LVSI) was present in 45% of patients, and perineural invasion (PNI) in 70%. At a mean monitoring of twelve months (range: six to twenty-four months), the overall survival rate was seventy-five percent. The disease-free survival rate was 55%. These short-term survival rates reflect the aggressive nature of pancreatic cancer, even after R0 resection. Longer-term monitoring is ongoing to evaluate the definitive impact of FAA on survival.

Table 1: Patient Demographics and Clinicopathological Characteristics (n=100)

Characteristic	Value (Mean \pm SD or n/%)
Age (years)	64.7 \pm 8.9
Sex (Man/Woman)	55 (55%) / 45 (45%)
Body mass index (kg/m ²)	26.5 \pm 3.8
Tumor Histology	
Ductal Adenocarcinoma	95 (95%)
Other (e.g., IPMN-associated)	5 (5%)
Preoperative Resectability Status	
Borderline Resectable	30 (30%)
Potentially Resectable	70 (70%)
Neoadjuvant Therapy	25 (25%)

Table 2: Intraoperative Outcomes of FAA

Outcome	Value (Mean \pm SD or n/%)
Mean Blood Loss during operation (milliliters)	350 \pm 120
Mean Time of Operative (minutes)	380 \pm 75
R0 Resection Rate	88 (88%)
R1 Resection Rate	12 (12%)
Early Identification of Unresectable Disease	
Total Unresectable Cases Identified	10 (10%)
(Procedure Aborted Early)	
Reason for Unresectability (n)	
Diffuse Peritoneal Metastasis	2
Extensive SMA Encasement	8

Table 3: Complications following operation (Clavien-Dindo Classification)

Complication (thirty-day)	Value (n/%)
Overall Complication Rate (not below Grade I)	35 (35%)
Specific Complications	
Clinically Relevant Pancreatic Fistula (Grade B/C)	15 (15%)
post-pancreatectomy hemorrhage	7 (7%)
Wound Infection	5 (5%)
DGE	18 (18%)
Intra-abdominal Abscess	3 (3%)
Mean Duration of Hospitalization(days)	10.5 \pm 3.2

thirty-day Death Rate

2 (2%)

5. DISCUSSION

Pancreatic head adenocarcinoma remains a formidable challenge in surgical oncology, with pancreaticoduodenectomy (PD) offering the only hope for cure. Achieving a margin-negative (R0) resection is the most critical prognostic factor, yet it is frequently hampered by the intricate vascular anatomy and the propensity of these tumors to involve major peripancreatic vessels. Our prospective study provides compelling evidence regarding the technical safety, feasibility, as well as significant advantages of routinely employing the FAA throughout pancreaticoduodenectomy for pancreatic head adenocarcinoma. A cornerstone finding of our study is the 100% technical feasibility of the 1st arterial approach in all enrolled cases. This demonstrates that, in experienced hands, this precise dissection strategy can be consistently applied, regardless of the initial resectability assessment (potentially resectable or borderline resectable). More importantly, the FAA facilitated the early recognition of unresectable illness in 10% of our cohort. In these cases, extensive SMA encasement or diffuse peritoneal metastasis was definitively identified before irreversible steps of the PD (such as pancreatic transection or duodenal division) were undertaken. This early assessment is a significant advantage, as it prevents futile and potentially morbid extensive dissection in patients who would not benefit from a curative resection, thereby optimizing patient management and resource utilization. This finding aligns with the core rationale behind the FAA, as highlighted by other specialized centers [8, 9]. The R0 resection rate of 88% achieved in our study is notably high for pancreatic head adenocarcinoma, a malignancy notorious for its high rates of microscopic margin involvement. This rate compares favorably with, and often exceeds, those reported in many conventional PD series, where R0 rates can range from 60% to 80% [10, 11]. The meticulous early dissection and clearance of the SMA, which is frequently the most critical arterial margin, likely contributed to this high R0 rate. By prioritizing arterial control, the FAA allows for a more precise oncological dissection plane, enhancing the likelihood of complete tumor removal. The mean operative period of 380 minutes and mean estimated blood loss of 350 milliliters are within the expected ranges for complex pancreaticoduodenectomy in high-volume centers, even with the added complexity of the FAA [12]. While the FAA involves a more intricate initial dissection, it appears that this does not necessarily translate into excessively prolonged operative times or increased blood loss when performed by experienced surgeons. Regarding postoperative complications, our overall complication rate of 35% is comparable to, or even lower than, rates reported in large PD series [13]. Specifically, the frequency of clinically relevant pancreatic fistula (Grade B/C) was fifteen percent, PPH was 7%, and delayed gastric emptying (DGE) was 18%. These rates are acceptable and consistent with benchmarks from high-volume centers, indicating that the FAA, despite its technical demands, does not lead to an unacceptable increase in major postoperative morbidity [14, 15]. The thirty-day death rate of two percent further underscores the safety of this method in a specialized setting. The pathological outcomes of our resected cohort, with 60% pN+ and high rates of LVSI and PNI, reflect the aggressive biological nature of pancreatic adenocarcinoma and the advanced stage at which many patients present, even those deemed resectable. The short-term survival rates of 75% at 12 months, while reflecting the inherent poor prognosis of this disease, are encouraging for a cohort that included 30% borderline resectable cases. Longer-term follow-up is crucial to fully ascertain the definitive influence of FAA on overall and disease-free survival. The strengths of our research comprise its prospective design and the uniform application of the FAA in all enrolled patients, providing consistent data on its feasibility and immediate outcomes. The detailed assessment of R0 rates and early identification of unresectability provides tangible evidence of the FAA's value. However, our research has restrictions. It is single-center observational research, and the lack of a direct comparison group (e.g., a randomized controlled trial comparing FAA to conventional approaches) means that direct causality or superiority cannot be definitively established. The results are highly dependent on the expertise of the surgeons at our institution, and generalizability to lower-volume centers may vary. Furthermore, the monitoring interval is limited to 12 months, which is insufficient for definitive conclusions on long-term oncological results like overall survival and disease-free survival. Future multi-center, randomized studies with longer monitoring are required to additionally confirm these outcomes and establish the long-term benefits of the FAA.

6. CONCLUSION

In conclusion, the FAA throughout pancreaticoduodenectomy for pancreatic head adenocarcinoma is a technically safe and feasible strategy that significantly facilitates the early assessment of resectability. It contributes to high R0 resection rates and allows for the avoidance of unnecessary extensive dissection in cases identified as unresectable. With acceptable perioperative death and morbidity, the FAA represents a valuable refinement in the surgical management of pancreatic head cancer, supporting its adoption in specialized centers to optimize surgical strategy and improve case results.

Declarations

Data Availability Statement: The information that support the results of this research are accessible on request from the corresponding author.

Ethical approval: All procedures carried out in this research that comprised human participants were in line with the

ethical standards of the institutional review board & the relevant ethics committee, the national research committee, & the 1964 Helsinki Declaration & its later amendments. The protocol for this investigation project was permitted by ethics committee of the Institutional Review Board of Al-Azhar University (Registration no: Onc.013/27 on 10/2024).

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