Original Article

Pancreatic Morphology/Contour Variations should be Recognized and Remembered

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Abstract

Background: Pancreatic contour variations can be detected incidentally on computed tomography (CT). Recognition and remembering of these variations are important in volumetric measurements and surgery as well as in preventing misdiagnosis. **Aim:** This study aims to evaluate the morphology/contour variations in the pancreas head-neck, body-tail, and uncinate process with multi-detector CT (MDCT) examinations (triple phase CT abdomen). **Material and Method:** Around 1662 adult age (>18 years old) patients were evaluated retrospectively, and after exclusion criteria, 945 patients were included in the study. Aplasia and hypoplasia of the uncinate process were determined, and pancreatic contour variances were categorized according to the Ross *et al*. and Omeri *et al*. classifications. Pancreatic head–neck variants were categorized into Type I-anterior, Type II-posterior, and Type III-horizontal variations. Pancreatic body–tail variants were sectioned into Type Ia-anterior protrusion, Type Ib-posterior protrusion, and Types IIa-globular, IIb-lobulated, IIc-tapered, and IId-bifid pancreatic tail. **Results:** Of the 945 patients, 481 (50.9%) were female. The mean age was 43.28 ± 10.49 (min. 20–max. 68). In the evaluations made according to the uncinate process morphology variant, hypoplasia was detected in 66 (7%) patients and aplasia in 12 (1.3%) patients. Pancreatic head-neck and body-tail contour variations were observed in 596 (63.1%) patients. The most common head-neck variation was Type II in 233 (24.6%) patients, followed by type III in 96 (10.2%). There were Type Ia in 83 (8.8%) patients and Type Ib in 14 (1.5%) patients. The pancreatic tail configuration was normal in 792 (83.8%) patients; it was Type IIa in 62 (6.6%) patients and IIb in 50 (5.3%) patients. The most common variation was head and tail in 33 (3.5%) patients. **Discussion:** Pancreatic variations detected in CT examinations for distinct reasons are not rare; these variations should be recognized and remembered.

Keywords: *Contour variation, multi-detector computed tomography, pancreas, uncinate process*

Introduction

The pancreas is an accessory gland of the digestive system, which plays a vital role in controlling energy consumption and metabolism and has endocrine and exocrine functions.[1] This organ, which is retroperitoneally located, non-encapsulated, is located in the epigastrium, left hypochondrium, and part of the umbilicus with an oblique course. It is examined in four parts: Head, neck, body, and tail. The superior mesenteric vein (SMV) is considered the anatomical landmark that separates the head and body of the pancreas; the part on the right side of the SMV is considered the head, and the part on the left is the body and tail.[2] While the head is located in the 'C' loop of the duodenum, the uncinate

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process is a hook-shaped medial-caudal extension of the head. About 60%–70% of the pancreas parenchyma is located in the head and uncinate process.[3] The neck is the narrow part that connects the head and body of the pancreas.[4] Although the distinction between body and tail is not clearly defined, the body is capriciously sectioned from the tail, exploiting one-half the distance from the left position of the SMV to the edge of the tail in the splenic hilum.[5]

Computed tomography (CT) scan is the first examination method used in suspected pancreatic diseases.[6] Contour variations can be detected incidentally in the pancreas in abdominal CT scans performed for distinct reasons. These variations can be misinterpreted as neoplasm, focal autoimmune pancreatitis, or ectopic pancreatic tissue.[7] It can cause unnecessary medical inspections and increase the financial burden. On the contrary, neoplasms, which are considered variations, may lead to delays in the treatment of patients and negative consequences in their prognosis.

It is important to know the pancreatic contour variations to evaluate the pancreatic volume. Because changes in pancreatic volume are closely related to the pathological conditions of the endocrine or exocrine functions of the pancreas. For example, while chronic pancreatitis and diabetes mellitus may decrease the size of the pancreas, it may increase acute pancreatitis, overweight, obesity, and neoplasms.[6,8] In addition, in pancreatic cancer patients, the remaining pancreatic volume after pancreatic resection can be used to determine the prognosis of these patients.[9] It is necessary to detect variations before operations, especially pancreatic transplantation, to prevent injuries that may occur during the operation.[7]

This study aims to evaluate morphology/contour variations in pancreatic head-neck, body-tail, and uncinate process with multi-detector CT (MDCT) examinations (triple phase CT abdomen).

Methods

Patient population and study design

After being approved by the Hospital Clinical Research Ethics Committee, adult-age (>18 years old) patients undergoing MDCT examinations (triple phase CT abdomen) in the hospital's radiology department between January 2015 and May 2022 were retrospectively reviewed. CT scan was performed for distinct reasons such as liver, gallbladder, kidney, spleen pathologies, vascular pathologies, and primary or metastatic tumor investigations. After exclusion criteria, 945 patients were included in the study [Figure 1].

CT examination protocol and image analysis

All patient's MDCT examinations were performed with a 128-detector row CT machine (GE Optima 660 SE 64 Detector 128-slice CT, General Electric Medical Systems, Milwaukee, USA). Examination parameters were 120 kV; 150 mAs; collimation 0.625 mm; slice thickness ≤2 mm; rotation time 0.5 s; pitch 1.014. One hundred non-ionic iodinated contrast agents were injected through an antecubital intravenous cannula at a rate of 2.5 ml/s. Scans were acquired in triple-phase (hepatic arterial, portal venous, and hepatic venous phase) using a Smart prep protocol with an enhancement threshold set at 100 Hounsfield units.

Image interpretation

MDCT evaluations were performed on a picture archiving and communication system (Extreme PACS, Ankara, Turkey). The radiologist analyzed the images with 15 years of abdominal radiology experience.

The region of the gland posterior to the SMV and medial to the pancreatic head was described as the uncinate process.

The uncinate process was described as developing normally when the medial portion of the pancreas' proximal inferior end level entirely traversed the SMV. Uncinate process hypoplasia was characterized as the right lateral wall boundary not being exceeded by the SMV of the medial portion of the proximal-inferior end level of the pancreas but rather being within proximity of the border. On the other hand, uncinate process aplasia was defined to exist when the right lateral wall of the SMV is not in contact with the medial portion of the proximal-inferior end level of the pancreas[10] [Figure 2].

Pancreatic contour alterations were categorized in the approach proposed by Ross *et al*.[11] and Omeri *et al*.[12]

Head–neck contour variations

By the position in which the gastroduodenal artery protrudes, the contour variations of the pancreatic head and neck are divided into three categories. The anterior superior pancreaticoduodenal artery has three forms: Anterior Type, posterior Type, and horizontal Type which are referred to as Types 1, 2, and 3, respectively [Figures 3 and 4a-c].

Body–tail contour variations

Type Ia-anterior protrusion: An anterior protrusion of a piece of normal pancreatic parenchyma with a maximum diameter of >1 cm. Type Ib-posterior protrusion: A part of normal pancreatic parenchyma that protrudes posteriorly from the body or tail and has a maximum diameter of >1 cm. The following pancreatic tail types are present: Type IIa-globular

tail; Type IIb-lobulated tail; Type IIc-tapering tail; Type IId-bifid tail [Figures 5 and 6a-f].

Contour variations of the pancreas matched the normal parenchyma in all phases.

Statistical analysis

Mean standard deviation, median, minimum, and maximum values were given in descriptive statistics for continuous data, and number and percentage values were given in discrete data. A Chi-square test was used to compare the variations according to gender. $P < 0.05$ was considered statistically significant.

Results

Of the 945 patients included in the study, 481 (50.9%) were female, and 464 (49.1%) were male. The mean age value was 43.28 ± 10.49 (SD) with min. and max. value of 20 and 68, respectively.

In the evaluations made according to the uncinate process morphology variations, hypoplasia was detected in 66 (7%) patients and aplasia in 12 (1.3%) patients [Table 1].

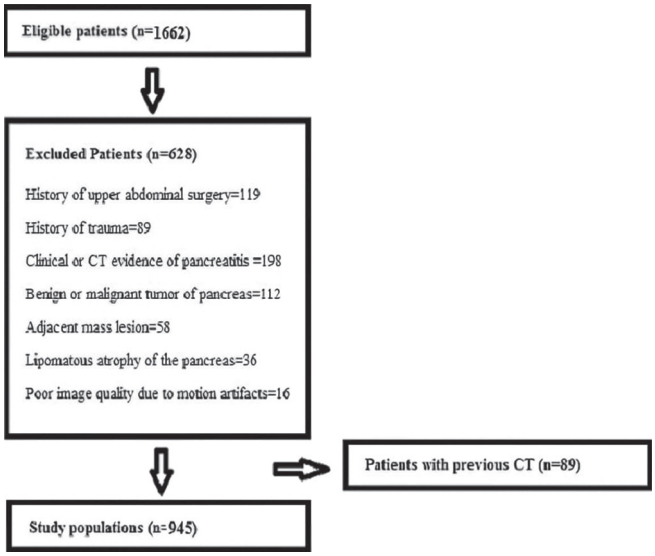

Figure 1: Flowchart of our study, 945 patients were included in the study

Pancreatic head-neck and body-tail contour variations were observed in 596 (63.1%) patients. The most common head-neck variation was Type II in 233 (24.6%) patients, followed by Type III in 96 (10.2%) [Table 2].

The pancreatic body was normal in 848 (89.7%) patients; Type Ia in 83 (8.8%) patients; and Type Ib in 14 (1.5%) patients were observed [Table 3]. The pancreatic tail configuration was normal in 792 (83.8%), Type IIa in 62 (6.6%), and IIb in 50 (5.3%) patients, respectively. Details are shown in Table 4. The most common

Table 1: The number and percentage of the pancreatic variants per uncinate process and gender

	Uncinate process			
	Normal *n* (%)	Aplasia *n* (%)	Hypoplasia *n* (%)	Total *n* (%)
Gender				
Female	442 (91.9)	8 (1.7)	31 (6.4)	481 (50.9)
Male	425 (91.6	4 (0.9)	35 (7.5)	464 (49.1)
Total	86 (91.7)	12 (1.3)	66 (7)	945 (100)

Table 2: Number and percentage of the pancreatic head-neck contour variants per gender

	Head-neck				
	Normal *n* (%)	Type 1 *n* (%)	Type 2 *n* (%)	Type 3 *n* (%)	Total *n* (%)
Gender					
Female	291 (60.5)	35 (7.3)	113 (23.5)	42 (8.7)	481 (50.9)
Male	255 (55)	35 (7.5)	120 (25.9)	54 (11.6)	464 (49.1)
Total	546 (57.8)	70 (7.4)	233 (24.6)	96 (10.2)	945 (100)

Table 3: Number and percentage of the pancreas body contour variants per gender

	Pancreas body			
	Normal *n* (%)	Type Ia *n* (%)	Type Ib *n* (%)	Total *n* (%)
Gender				
Female	427 (88.8)	47 (9.8)	7 (1.5)	481 (50.9)
Male	421 (90.7)	36 (7.8)	7 (1.5)	464 (49.1)
Total	848 (89.7)	83 (8.8)	14 (1.5)	945 (100)

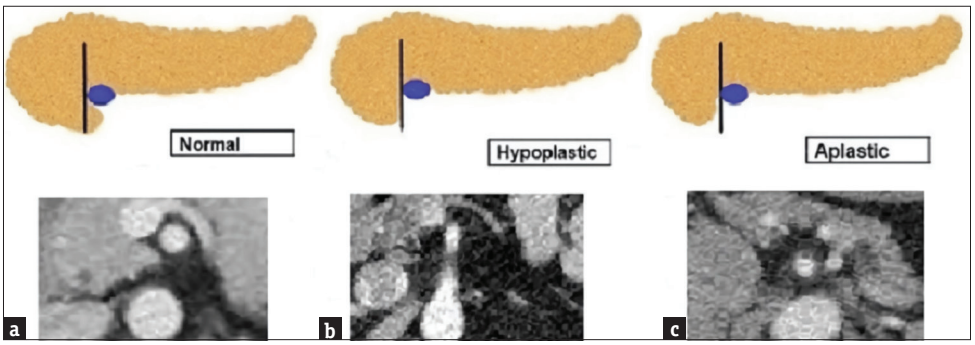

Figure 2: The illustration and axial computed tomography sections demonstrate the uncinate process of (a) normal, (b) hypoplastic, and (c) aplastic

variation in the study was head and tail variation co-occurrence with 33 (3.5%) patients [Table 5].

Discussion

Knowing the morphology/contour variations in the pancreatic head-neck, body-tail, and the uncinate process are crucial for the correct diagnosis in the patient. Incorrectly interpreted variations may result in unnecessary medical inspections or neoplasms considered as variants may adversely affect patients' prognosis. Furthermore, morphology/contour variations are important in the volumetric evaluation of the pancreas and in minimizing injuries during the operation.

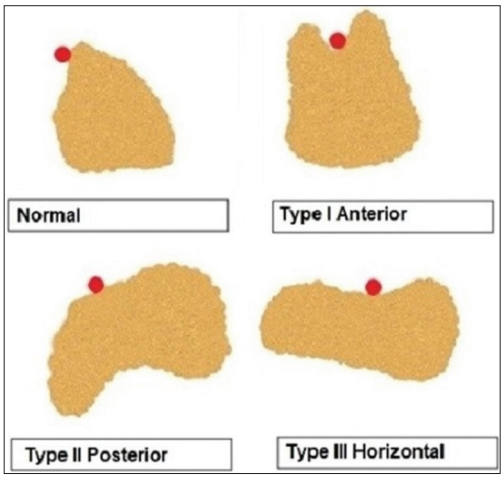

Figure 3: The illustration demonstrates contour variations in the pancreatic head normal, Type I, Type II and Type III

In the MDCT study by Omeri *et al*.,[12] clinical examinations and CT scan results detected variations in the pancreatic body-tail in 38 (8.5%) of 449 patients without pancreatic disease. In this study, which included a patient population of 945, diverse contour variations were observed in the pancreas of 596 (63.1%) patients. In addition to the pancreatic body-tail examinations, the fact that head and neck variations were also evaluated is thought to increase the number of diverse contour variations found in this study.

Embryological development of the pancreas is complex; therefore, it has a wide range of variations. In the fifth week, dorsal and ventral buds develop from the primitive foregut that forms the duodenum in the fetus.[5] The ventral pancreatic bud rotates 180° in tandem with the foregut to produce the stomach and the duodenal loop, and it then positions itself next to and caudal to the dorsal pancreatic bud.[3] The dorsal pancreas displays the front portion of the head, body, and tail, while the ventral pancreatic bud presents the posterior portion of the head and the uncinate process.[4] In individuals with nonrotation, the uncinate process was aplastic or hypoplastic, which could have been related to mesenteric

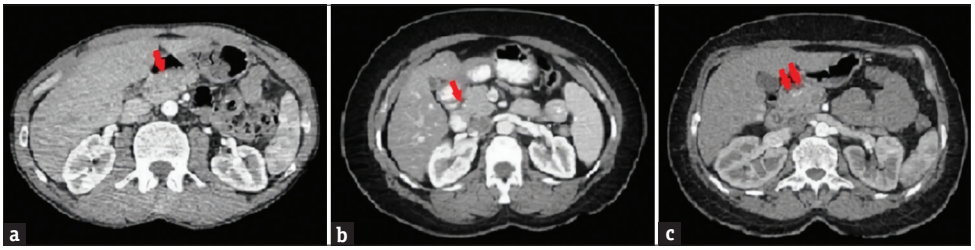

Figure 4: The axial computed tomography sections demonstrate contour variations in the pancreatic head, (a) Type I, (b)Type II, (c) Type III

Table 4: Number and percentage of the pancreatic tail contour variants per gender

	Tail					
	Normal *n* (%)	Type IIa *n* (%)	Type IIb *n* (%)	Type IIc *n* (%)	Type IId *n* (%)	Total *n* (%)
Gender						
Female	403 (83.8)	31 (6.4)	26 (5.4)	13 (2.7)	8 (1.7)	481 (50.9)
Male	389 (83.3)	31 (6.7)	24 (5.2)	13 (2.8)	7 (1.5)	464 (49.1)
Total	792 (83.8)	62 (6.6)	50 (5.3)	26 (2.8)	15 (1.6)	945 (100)

Table 5: Numbers and percentage of co-occurring variations contour variants per gender

	Co-occurring variants (head, body, tail)				
	Normal *n* (%)	Head+Tail *n* (%)	Body+Tail *n* (%)	Head+Body+Tail *n* (%)	Total *n* (%)
Gender					
Female	182 (37.8)	17 (3.5)	2 (0.4)	2 (0.4)	481 (50.9)
Male	167 (36)	16 (3.4)	6 (1.3)	4 (0.9)	464 (49.1)
Total	349 (36.9)	33 (3.5)	8 (0.8)	6 (0.6)	945 (100)

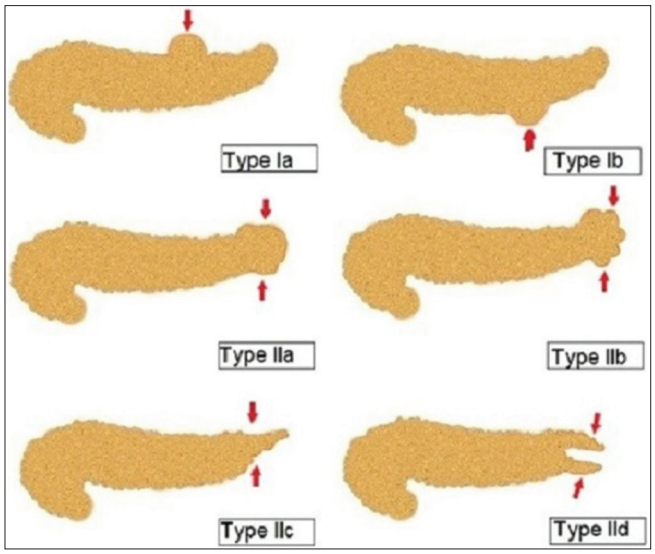

Figure 5: The illustration demonstrates contour variations in the pancreatic tail Type Ia, Type Ib, Type IIa, Type IIb, Type IIc, Type IId

vascular inversion and insufficient rotation of the ventral bud of the pancreatic primordium.[13]

Şahin *et al*.[14] observed aplasia or hypoplasia of the pancreatic uncinate process in 21 (65.6%) patients with intestinal malrotation, while Chandra *et al*.[10] identified it in 18 (86%) patients in a similar study. In this study, uncinate process aplasia and hypoplasia were detected in 12 (1.3%) and 66 (7%) patients, respectively, but the patients were not evaluated for intestinal malrotation.

The five year survival rate for pancreatic cancer, which is the fourth most deadly cancer among cancer types in the world, is below 5%.[15] Pancreatic cancer is most common in the head; therefore, contour variations of this pancreatic head should be considered in the differential diagnosis of cancer.[16] It is thought that the contour variation of the pancreatic head is due to the variation in the fusion between the ventral and dorsal pancreas.[11] Ross *et al*.[11] found a contour variation in the head and neck of the pancreas in 34.5% of 119 patients evaluated with dual-phase helical CT. These were Type II (19%), Type I (10%), and Type III (5%), respectively. Sureka *et al*.[7] observed Type II (21.3%), Type III (7%), and Type I (4%) head-neck contour variations, respectively, in their MDCT examination study with 524 patients using the same classification. In this study, head-neck contour variations of Type 2 (24.5%), Type 3 (10.1%), and Type 1 (10.2%) were observed, respectively, and their rates were higher than those in other studies. It may be due to our study group's higher number of patients.

In studies, the anterior protrusion is observed between 4.6% and 8.5% of pancreatic body variations, and the posterior protrusion is rarely observed.[7,12,17] Similarly,

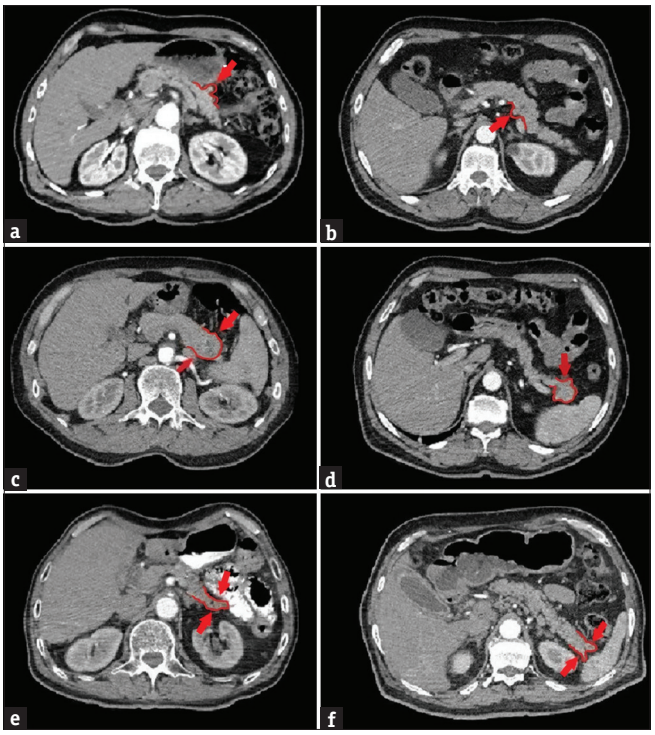

Figure 6: The axial computed tomography sections demonstrate contour variations in the pancreatic tail (a) Type Ia, (b) Type Ib, (c) Type IIa, (d) Type IIb, (e) Type IIc, (f) Type IId

Type Ia-anterior protrusion was found more frequently than posterior protrusion in pancreatic body variations in this study.

The pancreas is anatomically associated with the peritoneal reflections in the abdomen, which include the transverse mesocolon and the small bowel mesentery, and it is physically connected to peritoneal ligaments, namely, the hepatoduodenal ligament, gastrohepatic ligament, splenorenal ligament, gastrocolic ligament, and greater omentum.[3] It is thought that the retromesenteric plane on the left prevents the pancreas from protruding posteriorly due to the anatomical neighborhood of the pancreas, the folds made by the peritoneum, and the presence of fused fascial layers. Therefore, the posterior protrusion is rarely observed.[12,17] In a study by Dilek *et al*.[17] in which MDCT of 899 patients was evaluated, the most common tail variations were 8% globular and 4.4% globular–lobular. In the study of Sureka *et al*.,[7] which used a similar classification, the most common tail variations were Type IIb 4% and Type IIa 3.6%. This study's most common tail variations were Type IIa in 62 (6.6%) patients and Type IIb in 50 (5.3%) patients. It should be kept in mind that Type IIa and Type II b variations observed in the tail of the pancreas may be confused with intrapancreatic accessory spleen and non-functional neuroendocrine neoplasms in non-contrast CT examinations.[12,18]

Uomo *et al*.[19] observed a bifid tail of the pancreas in 7% of 650 patients who underwent endoscopic retrograde cholangiopancreatography. The least common tail variation in this study was a Type II d of the pancreas, with a rate of 1.6%. Similarly, in the study of Dilek *et al*.,[17] the least observed tail variation was a bifid tail of the pancreas (1.8%). This variation, also called fishtail pancreas due to its bifid tail appearance, is a rare but clinically significant variation because it causes localized acute pancreatitis and/or recurrent pancreatitis attacks.[20,21] The bifid pancreatic tail does not regress in one of the ventral lobes during the embryogenesis stage, and ductal bifurcations occur at this level with the formation of the dorsal and ventral tail; therefore, it is thought that patients with this variation are predisposed to pancreatitis.[22,23]

In this study, the most common co-occurring variations were head and tail variations with 33 (3.5%) patients. To the best of our knowledge, no comprehensive investigation on the co-occurrence of contour variations using the same categorization has been published in English literature. In our opinion, co-occurring variations may be caused by the anatomical location of the pancreas, the complexity of its embryological development, and certain genetic factors affecting this development. It is hoped that researchers will develop new theories on this subject in the future and examine this area in more detail.

The strength of our study is the high number of patients, and the radiological examination method and protocol are the same. The limitations are that the study was single-centered, and a CT scan was performed only on axial sections. More variations could have been detected if it had been evaluated in sagittal and coronal sections. Moreover, the patients with pancreatic uncinate process aplasia and hypoplasia were not evaluated in terms of intestinal malrotation because it was not in the study plan. In addition, intraobserver and interobserver evaluations were not performed.

Conclusion

Pancreatic variations detected in CT examinations performed for distinct reasons are not uncommon. These variations are significant in differentiating pathological conditions, especially neoplasms, volumetric evaluations, and surgery. In our opinion, these variations are related to the embryological development of the pancreas, peritoneal coverings, and genetic factors.

Ethics committee approval

This study was approved by the University of Health Sciences, Dışkapı Yıldırım Beyazıt Training, and Research Hospital Clinical Research Ethics Committee (Date: 08/2022 Decision: 143/12.).

Informed consent

Retrospective study.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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