

CASE REPORT

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Diagnosis of pancreatic head cancer with prominent fatty change in the pancreatic body using 3 Tesla-enhanced magnetic resonance imaging: A case report

Kyosuke Goda, Tomoo Miyake, Tatsuki Sato, Yamato Tada,
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ABSTRACT

Introduction: Pancreatic cancer is the seventh leading cause of cancer-related deaths worldwide, and early diagnosis is necessary to obtain a favorable postoperative prognosis. Contrast-enhanced computed tomography is generally recommended when pancreatic cancer is suspected. Herein, we present a case in which contrast-enhanced magnetic resonance imaging was used to detect pancreatic cancer, while contrast-enhanced computed tomography and endoscopic ultrasonography were unable to reveal possible pancreatic cancer.

Case Report: We present a case of a man in his 70s whose diabetes had worsened, and the main pancreatic duct was dilated, with suspicion of pancreatic cancer. Contrast-enhanced computed tomography did not reveal a tumor that indicated possible pancreatic cancer, and endoscopic ultrasonography exhibited similar findings. Therefore, 3 Tesla-enhanced magnetic resonance imaging was performed to make an image diagnosis of pancreatic cancer.

Conclusion: In lesions exhibiting invasive growth accompanied by prominent fatty change in the pancreatic body, obtaining the contrast effect of adipose tissue by contrast computed tomography is difficult. In addition, an association between prominent fatty change in the

pancreatic body and pancreatic cancer has been reported. Therefore, we performed 3 Tesla-enhanced magnetic resonance imaging examination, which tends to yield favorable tissue contrast on adipose tissue images.

Keywords: Fatty change, Pancreatic body, Pancreatic head cancer, 3-T enhanced magnetic resonance imaging

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INTRODUCTION

Pancreatic cancer is the seventh leading cause of cancer-related deaths worldwide [1], and the cancer-related mortality rate is estimated to be 2.5 and 14.8 per 100,000 people in developing and developed countries, respectively [2]. According to the Union for International Cancer Control (UICC), the 5-year survival rate of pancreatic cancer at the T1 and IA stages is approximately 68.7% [3]. Early diagnosis is necessary to obtain a favorable postoperative prognosis for pancreatic cancer. However, pancreatic cancer is characterized by a malignant tumor that is difficult to diagnose early, with 47.4% of cases already progressing to stage IV at the time of diagnosis [4]. Among various proposed diagnostic methods, contrast-enhanced computed tomography (CT) exhibits high diagnostic ability in both sensitivity

and specificity [5–7], which are reported to be 77% and 100%, respectively, even for small pancreatic tumors [8]. Contrast-enhanced magnetic resonance imaging (MRI) theoretically visualize cancer lesion at an earlier stage by providing a comprehensive analysis of the morphological changes of the pancreas parenchyma. Despite this, contrast-enhanced MRI has almost the same sensitivity and specificity as that of contrast-enhanced CT [9–12]. For this reason, MRI is not widely used as the primary imaging modality due to the length and cost of imaging time and availability.

Various lifestyle habits such as cigarette smoking, high body mass index, diabetes, and chronic pancreatitis have been reported as a risk factor for pancreatic cancer [13–16]. Furthermore, Emily et al. have investigated the diffuse pancreatic steatosis associated with metabolic syndrome for the risk of pancreatic cancer [17]. On the other hand, only a few case series have reported the direct relationship between focal fatty change in the pancreas and localization of pancreatic cancer [18]. In this report, we present a unique case of pancreatic head cancer which was not visible on contrast-enhanced CT due to prominent fatty change, for which 3 Tesla (3-T)-enhanced MRI was useful for diagnosis; furthermore, we also review the associated literature.

CASE REPORT

We were presented with a male patient in his 70s whose main complaint was weight loss. The patient had a history of hypertension, diabetes, and rectal cancer; his social history included no alcohol consumption and smoking history of 20 cigarettes/day for 55 years. He also reported no allergies. The patient was being treated for diabetes by a family doctor, was administered several hypoglycemic agents, and his glycosylated hemoglobin (HbA1c) concentration (7.0%) was stable. Starting in February 2019, his HbA1c concentration rose sharply to $\geq 10.0\%$, and his body weight decreased by ≥ 5 kg in half a year. An abdominal echo performed by a family doctor revealed dilation of the main pancreatic duct, and pancreatic head cancer was suspected.

A blood test revealed increases in HbA1c and carcinoembryonic antigen to 11.2% and 8.7 ng/mL, respectively. Abdominal ultrasonography and Sonazoid® (Daiichi-Sankyo, Tokyo, Japan; GEHealthcare, Milwaukee, WI, USA) enhanced ultrasound (Figure 1) did not reveal a hypoechoic figurine indicative of pancreatic cancer on the pancreatic head side of the dilated main pancreatic duct. In the horizontal-section image of the contrast-enhanced CT arterial phase (Figure 2), a tumor suspected to be typical of pancreatic cancer that was contrasted late on the pancreatic head side of the interrupted main pancreatic duct, could not be recognized. In the coronary image (Figure 3), the pancreas was atrophied from the body to the head and there was dilation of the main pancreatic duct, revealing prominent fatty change in

the pancreatic body; however, no neoplastic lesion was detectable (Figure 4). Endoscopic ultrasonography (EUS) revealed dilation of the main pancreatic duct and atrophy of the pancreas as on the abdominal ultrasonography; nevertheless, the tumor could not be clearly visualized. Therefore, histological diagnosis using endoscopic ultrasound-guided fine-needle aspiration (EUS-FNA) was considered difficult. Hence, we decided to conduct a detailed examination using other modalities.

We conducted 3-T contrast-enhanced MRI which revealed a low-intensity mass of approximately 1 cm in the pancreatic head on T1-weighted images and on T2 fat suppression; it was recognized as a tumor, exhibiting clearer high-intensity than did the adipose tissue (Figure 5). In addition, the lesion showed high intensity on diffusion-weighted imaging (DWI) and low intensity on the apparent diffusion coefficient (ADC), indicating that pancreatic cancer was present in the pancreatic head. Gadolinium-enhanced MRI (Figure 6) revealed that the mass was late-enhanced, and we were able to make a definitive diagnosis of pancreatic cancer. Endoscopic retrograde pancreatography (ERP) and magnetic resonance cholangiopancreatography (MRCP) (Figure 7) confirmed disruption of the main pancreatic duct and dilation of the pancreatic duct. Serial pancreatic juice aspiration cytological examination (SPACE) was performed. After performing endoscopic nasopancreatic drainage and pancreatic duct brush cytology, pancreatic juice was collected thrice via a pancreatic catheter. Cytopathology revealed class IIIa disease (Papanicolaou classification). Based on the imaging test results, the patient was confidently diagnosed with pancreatic cancer (T1c, No, Mo, stage IA), and we decided to perform pancreaticoduodenectomy as treatment.

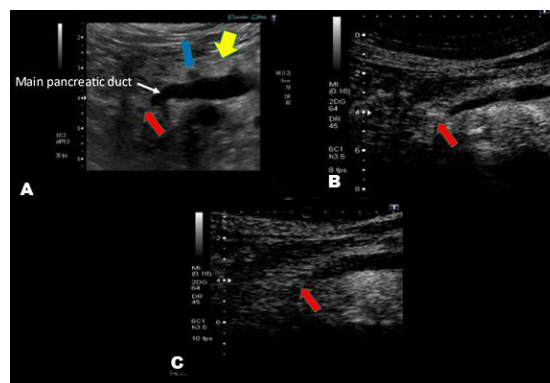


Figure 1: Abdominal ultrasonography (AUS) at the first visit, before Sonazoid® angiography (A), in the early vascular phase (B), and in the late vascular phase (C) are shown. Adipose-degenerated tissue was visualized as a hyperechoic image (yellow arrow). Atrophied pancreatic tissue due to inflammation of pancreatitis obliterans was visualized as a hypoechoic image around the main pancreatic duct (blue arrow). The dilated main pancreatic duct was occluded at the pancreatic head. A hypoechoic image suggestive of pancreatic cancer could not be identified in the blocked part of the pancreatic duct (red arrow). Subsequently, Sonazoid imaging was performed; however, no late-onset mass was visualized (red arrow).

In the resected histopathological specimen (Figure 8), cancer cells had invaded the highly fatty pancreatic tissue, and posterior invasion of the pancreatic tissue was also observed. The pancreatic tumor was classified as pT2, pN1, Mo, G3, R1, stage IIB according to the tumor-node-metastasis classification (UICC, 8th edition). Since the progression of pancreatic cancer was judged to be R1, which indicates that the cancer tissue could not be completely resected, we decided to perform postoperative adjuvant chemotherapy.

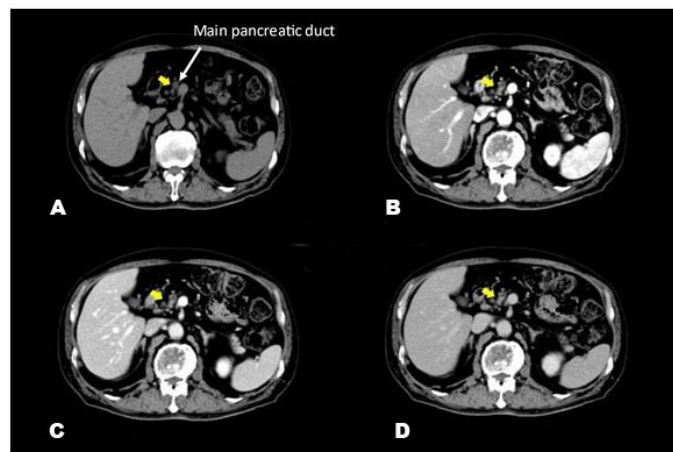


Figure 2: Pre-contrast (A), arterial phase (B), portal phase (C), and venous phase (D) images of the abdominal contrast-enhanced CT (computed tomography) at the first visit are shown. No tumor-causing obstruction was visualized on the pancreatic head side of the dilated main pancreatic duct, and soft tissue exhibiting a contrast enhancement effect similar to that of normal pancreatic tissue was observed (yellow arrow).

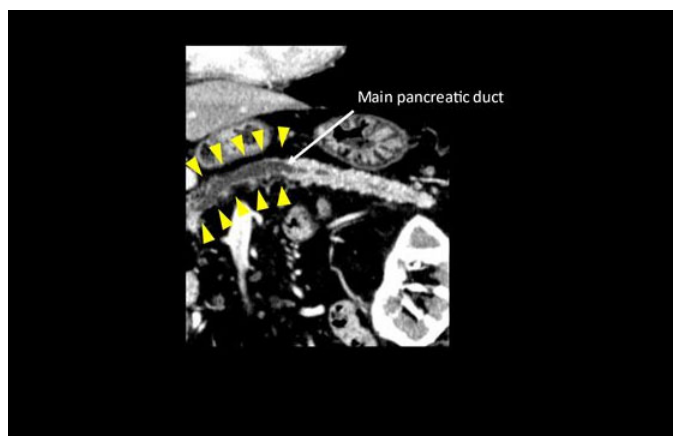


Figure 3: A coronal image of the arterial phase of the abdominal contrast-enhanced CT is shown. The pancreatic tissue surrounding the dilated main pancreatic duct was focally atrophied (yellow triangle) and replaced with fatty pancreatic tissue. As in the horizontal cross-sectional image, no tumor could be identified in the obstruction of the main pancreatic duct.

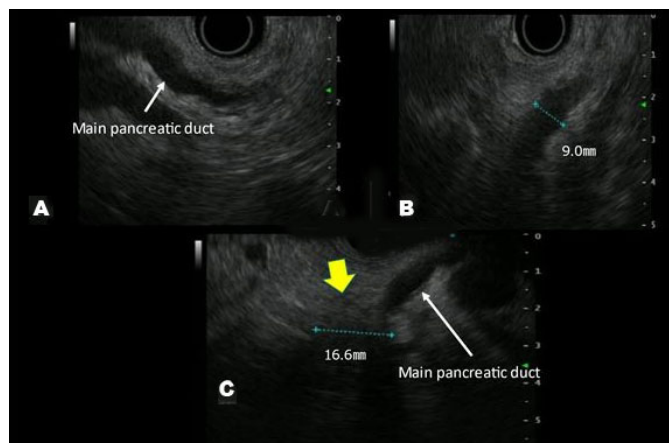


Figure 4: Images of the pancreatic body (A and B) and pancreatic head (C) via endoscopic ultrasonography (EUS) are shown. The main pancreatic duct dilated to 9.0 mm, as in AUS. Observation of the pancreatic head from the duodenum revealed a slightly irregular hypoechoic area (yellow arrow), which could not be clearly visualized as a tumor. In addition, the reproducibility of the images was low, suggesting the possibility that the images exclusively captured changes in chronic pancreatitis.

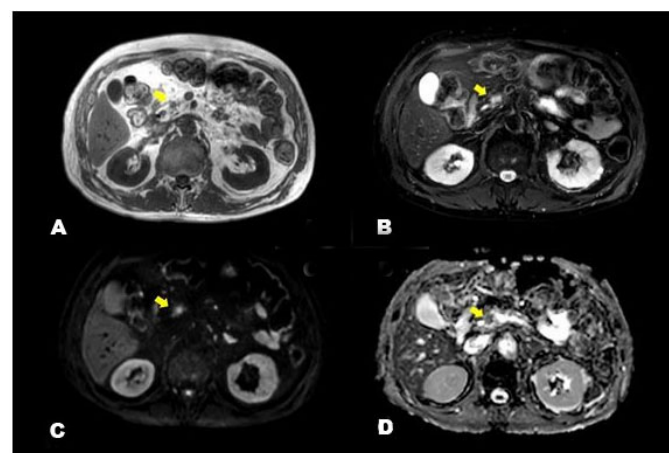


Figure 5: Images from 3-T enhanced magnetic resonance imaging (MRI) are shown. The T1-weighted image (in-phase) (A), T2-weighted image (fat suppression) (B), diffusion-weighted image (DWI) (C), and the apparent diffusion coefficient (ADC) (D) are shown. All yellow arrows point to the tumor. On the T1-weighted image, a low-intensity mass of approximately 1 cm was observed in the pancreatic head, and on the fat-suppressed T2-weighted image, it was recognized as a tumor, exhibiting clearer high-intensity than the adipose tissue. The DWI shows a high signal, and the ADC shows a low signal.

DISCUSSION

Herein, we present a case of pancreatic head cancer with prominent fatty change in the pancreatic body that was difficult to diagnose. Finally, we performed definitive imaging diagnosis using 3-T enhanced MRI. Compared with that of conventional 1.5-T MRI, 3-T MRI has twice the static magnetic field strength and provides high spatial resolution; thus, its usefulness in the imaging diagnosis of pancreatic cancer has been reported [19–21].

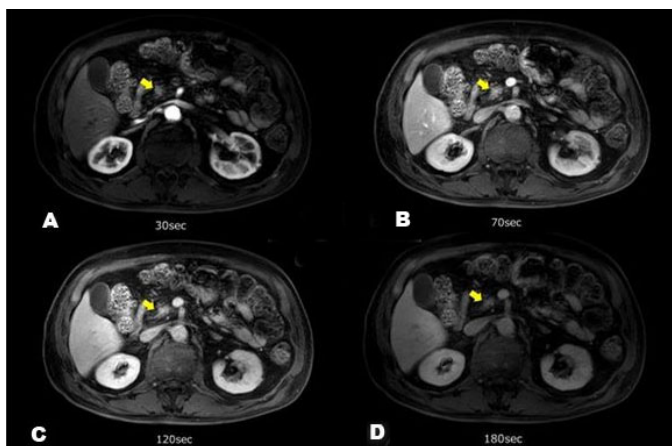


Figure 6: Thirty-second (A), 70-s (B), 120-s (C), and 180-s (D) gadolinium-enhanced MRIs (magnetic resonance imaging) are shown. A mass (yellow arrow) clearly showing a late-onset contrast-enhancing effect in the head of the pancreas.

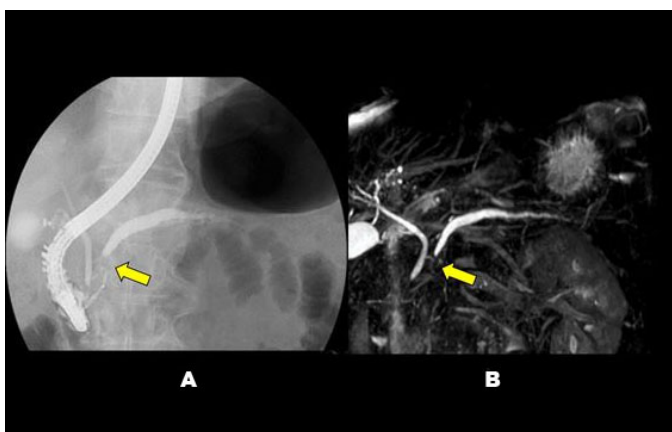


Figure 7: Contrasting images of endoscopic retrograde pancreatography (ERP) (A), pancreatography, and magnetic resonance cholangiopancreatography (MRCP) (B) are shown. In both images, disruption of the pancreatic duct at the pancreatic head (yellow arrow) and dilation of the main pancreatic duct were observed. MRCP by 3-T MRI shows that bile ducts and pancreatic ducts were accurately visualized with high contrast.

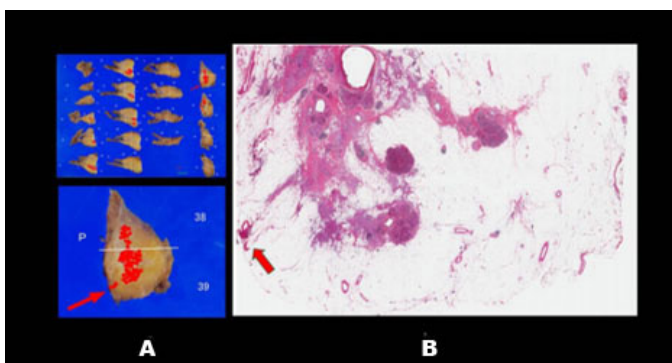


Figure 8: A sagittal section of the pancreatic head, which contains the most tumor tissue in the resected pathological specimen (A), and histology of the tumor (B) are shown. Red dots indicate the sites of cancer cell distribution. Scattered invasive cancer cell proliferation was observed in the highly fatty pancreatic tissue, and posterior infiltration of cancer cells into the pancreas, which could not be detected by imaging, was observed (red arrow).

In a study comparing the usefulness of 3-T contrast-enhanced MRI with that of multidetector computed tomography (MD-CT), no significant difference was observed between MD-CT and 3-T MRI in the sensitive and specific in diagnosing and staging pancreatic cancer respectively [9–12]. Because of the sensitivity and specificity of MD-CT are already enough high [5–8], it is likely difficult to find a statistically significant difference when compared with MD-CT. Nevertheless, most expert opinion shows the added utility of MRI over MD-CT in particular situations including the differentiating isoattenuating pancreatic lesions [22]. Furthermore, specific situations MRI seems to have an advantage over MD-CT in differentiating pancreatic tumors in mass-forming pancreatitis, in the presence of hypertrophied pancreatic head or focal fatty infiltration of the parenchyma [23]. In this case, 3-T contrast-enhanced MRI was clearly superior to contrast-enhanced CT in the visualization and enhancement of the lesion. In lesions that exhibit invasive growth in pancreatic tissue are highly adipose-degenerated, obtaining contrast between the adipose tissue and such lesions on contrast-enhanced CT may be difficult. In contrast, 3-T MRI examination, which can easily obtain tissue contrast with good fat suppression images, is considered more useful for diagnosing such lesions. In the authors' experience, 3-T contrast-enhanced MRI is often used as a second-line imaging modality for a high clinical suspicion of pancreatic cancer despite none being visible on CT.

However, making a differential diagnosis between pancreatic cancer and an inflammatory mass based on imaging alone is not easy. Of the patients diagnosed with pancreatic cancer based on imaging tests alone, 10.7% had benign diseases, such as chronic pancreatitis, among those who underwent pancreaticoduodenectomy [24]. In this case, visualizing the tumor clearly using EUS was difficult; therefore, histological diagnosis using EUS-FNA was considered unreliable and difficult. SPACE has been reported to be highly useful in diagnosing pancreatic cancer [25]. Therefore, we attempted to make a definitive diagnosis using SPACE; however, the cytopathological diagnosis was class III; hence, we could not make a definitive preoperative diagnosis. Nevertheless, we believe that actively performing pancreatic cancer surgery in cases where the tumor cannot be clearly visualized is preferred, such as in this case.

In this case, prominent fatty change in the pancreatic body was observed from the pancreatic head adjacent to the lesion compared to the tail. Atrophy, fibrosis, and steatosis of the pancreas are generally recognized as some of the age-related changes [26]. Nonetheless, pancreatic cancer is potentially related to focal atrophy and fatty change in the pancreas [18, 27]. The peroxisome proliferator-activated receptor γ (PPAR γ) is an intracellular transcription factor required for the differentiation and maturation of adipocytes. Peroxisome proliferator-activated receptor γ activation suppresses transforming growth factor- β , resulting in the suppression

of pancreatic cancer growth [28, 29]. Kikuyama et al. proposed that PPAR γ may be activated to suppress cancer progression at sites where pancreatic cancer exists, resulting in fatty transformation of the surrounding pancreatic tissue [18]. As in this case, we speculate that prominent fatty change in the pancreatic body near the tumor was caused by obstructive pancreatitis due to pancreatic duct obstruction and PPAR γ activation by cancer. In recent years, a small number of case reports on focal fatty change in the pancreatic body and pancreatic cancer have surfaced [18]. A study that quantitatively evaluated pancreatic adiposity using MRI-proton density fat fraction (MRI-PDFF) found that MRI-PDFF and the histological pancreatic fat fraction were higher in pancreatic cancer cases [30]. The case findings also support the possibility of using fatty changes in pancreatic tissue as an essential imaging biomarker for the early detection of pancreatic cancer. To prove the usefulness of this key finding, it is necessary to accumulate related case reports in the future.

CONCLUSION

In lesions exhibiting invasive growth accompanied by prominent fatty change in the pancreatic body, obtaining the contrast effect of adipose tissue by contrast computed tomography is difficult. In addition, an association between prominent fatty change in the pancreatic body and pancreatic cancer has been reported. Therefore, we performed 3 Tesla-enhanced magnetic resonance imaging examination, which tends to yield favorable tissue contrast on adipose tissue images. To prove the usefulness of this key finding, it is necessary to accumulate related case reports in the future.

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Author Contributions

Kyosuke Goda – Conception of the work, Design of the work, Acquisition of data, Analysis of data, Interpretation of data, Drafting the work, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

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Koji Yoshida – Conception of the work, Design of the work, Acquisition of data, Analysis of data, Interpretation of data, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Guarantor of Submission

The corresponding author is the guarantor of submission.

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Written informed consent was obtained from the patient for publication of this article.

Conflict of Interest

Authors declare no conflict of interest.

Data Availability

All relevant data are within the paper and its Supporting Information files.

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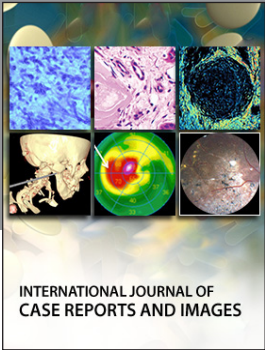
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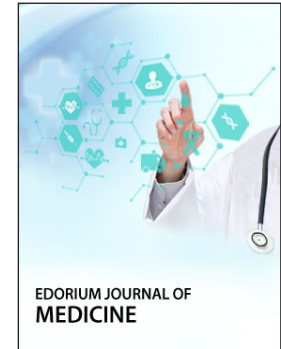
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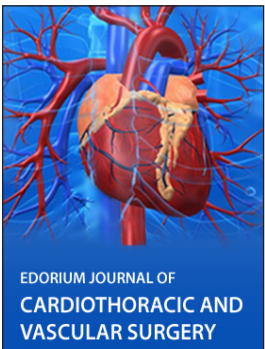
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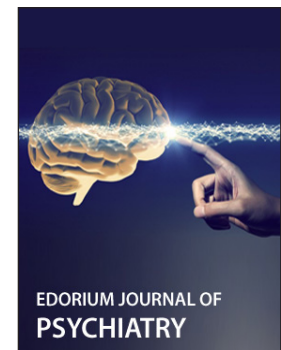
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