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Mini Review

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How pancreatic adenocarcinoma might cause diabetes? The role of TGF- β

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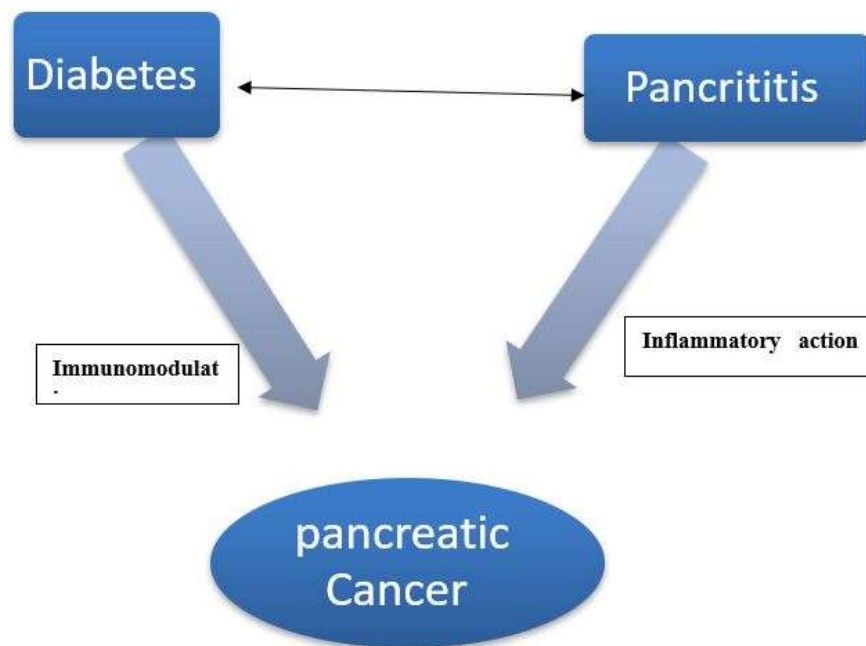
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Abstract

Pancreatic ductal adenocarcinoma (PDAC) is a deadly sickness that stays incurable due to past due diagnosis, which renders any healing intervention challenging. Most PDAC sufferers expand de novo diabetes, which exacerbates their morbidity and mortality. How PDAC triggers diabetes continues to be unfolding. Using a mouse version of KrasG12D-pushed PDAC, which faithfully recapitulates the development of the human sickness, we determined a large and selective depletion of β -cells, taking place very early on the degrees of preneoplastic lesions. Mechanistically, it turned into observed that accelerated TGF beta (TGF- β) signaling throughout PDAC development induced erosion of β -mobileular mass thru apoptosis. Suppressing TGF- β signaling, both pharmacologically thru TGF- β immunoneutralization or genetically thru deletion of Smad4 or TGF- β kind II receptor (T β RII), afforded size able safety in opposition to PDAC-pushed β -mobileular depletion. From a translational perspective, each activation of TGF- β signaling and depletion of β -cells often arise in human PDAC, imparting a mechanistic cause of the pathogenesis of diabetes in PDAC sufferers, and similarly implicating new- onset diabetes as a capability early prognostic marker for PDAC. In this mini review we try to analyze the principle relationships between pancreatic cancer and diabetes and vice versa in addition to the implication of TGF- β signaling as a likely goal for attenuating diabetes in pancreatic most cancers patients.

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Graphical Abstract

Introduction

Pancreatic ductal adenocarcinoma (PDAC) is one of the most deadly human malignancies, with a mean survival of much less than 6 mo and a cumulative 5-year survival rate of 3-7% [1]. PDAC can develop from pancreatic intraepithelial neoplasia (PanIN), intraductal papillary mucinous neoplasia, or mucinous cystic neoplasia, even though PanINs constitute the most common precursor lesions [2]. The considerable majority of PDAC tumors (~90%) harbor activating mutations with inside the proto-oncogene KRAS, most commonly KRASG12D [2,3]. Constitutively activated KRAS induces most cancers cellular proliferation with the aid of using growing glucose in take about ten instances extra than in ordinary cells, a phenomenon referred to as the Warburg effect [4]. Given this dependency on glucose, one could surmise that hyperglycemia, which is usually related to diabetes, should play an instrumental position with inside the pathogenesis and development of PDAC with

the aid of using offering the glucose had to as the increase of most cancers cells. Interestingly, approximately 80% of PDAC sufferers expand kind 2 diabetes (T2D), and PDAC prevalence is instances better in diabetic sufferers than in non-diabetic individuals [5]. Conversely, sufferers who are recently been diagnosed with diabetes are 50% more likely to develop PDAC than healthy people [6]. Genetic studies using the KPC mouse model of PDAC show that the development of PDAC did not exacerbate high-fat diet (HFD)-induced diabetes [7], and PDAC causes insulin resistance. It suggests that it can cause diabetes without. However, the underlying mechanism of the detrimental link between PDAC and diabetes is still poorly understood. Diabetes is a debilitating metabolic disorder characterized by hyperglycemic levels due to defects in insulin production, insulin signaling, or both. Diabetes has two broad pathogenic categories. Type 1 diabetes (T1D) due to an absolute deficiency of insulin and T2D caused by a combination of insulin resistance and inadequate compensation for insulin secretion. T1D accounts for 5-10%, T2D accounts for 90-95% of all diabetics [2].

Langerhans cells represent the endocrine system of the pancreas and play an important role in the pathogenesis of T1D and T2D. The islets of Langerhans are mainly composed of glucagon, insulin, somatostatin, PP-producing α , β , and pancreatic polypeptide (PP) cells [8]. Although these endocrine cells perform different functions, the interactions between them are important in maintaining glycemic homeostasis throughout the body [2]. For example, insulin secreted by β -cells plays a role in suppressing gluconeogenesis in the liver, while glucagon secreted by α -cells has the opposite effect. It remains to be seen whether the acquisition of carcinogenic KRAS in the pancreatic epithelium affects fate or the function of one of these islet cells. In this mini review we try to analyze the principle relationships between pancreatic cancer and diabetes and vice versa in addition to the implication of TGF- β signaling as a likely goal for attenuating diabetes in pancreatic most cancers patients.

TGF – β Theory

In addition to carcinogenic mutations in KRAS, other genetic changes that may be essential for progression from early neoplastic lesions to invasive PDAC are the tumor suppressor SMAD4 (also known as DPC4) and the TGF β II receptor (also known as DPC4). It is a non-functional mutation of T β RII). Components of the TGF β signaling pathway [9] Cancer Genome Atlas Research Network, 2017. TGF β signaling regulates a variety of functions, including embryonic development, proliferation, differentiation, and identification of cell fate during apoptotic cell death [2]. The TGF β signaling pathway is initiated when the ligand induces the assembly of heteromer T β RII and T β RI (TGF β type I receptor) complexes, allowing phosphorylation and activation of T β RI kinase by constitutively active kinases of T β RII [2]. Activated T β RI then propagates the signal to the nucleus by phosphorylating Smad2 and Smad3 at the two C-terminal serine residues (S465 / S467). After

phosphorylation, Smad2 and Smad3 bind to their common partner, Smad4, and the resulting complex translocates to the cell nucleus, where TGF β target gene expression is expressed through coordinated interaction with transcriptional coactivators or corepressors Adjust [2]. Interest in the use of the TGF β signaling pathway in cancer stems from its dichotomized role as a tumor suppressor and tumor promoter [10].

Indeed, TGF β It suppresses growth or induces apoptosis in most normal epithelial cells, thereby inhibiting tumor initiation. On the other hand, TGF β acts as a metastasis-promoting factor because it can enhance the progression of already established tumors. The mechanical basis for this bimodal effect of the TGF β signaling pathway is currently poorly understood. During the course of PDAC, increased TGF β secretion from both the cancer cells and the surrounding interstitium results in excessive TGF β signaling, and this activation is known to be associated with reduced survival in PDAC patients [11]. Of particular importance is the increase in TGF β signaling that occurs in early PanIN without recognizable metastases [11], and activation of this signaling pathway goes beyond mere cellular repression. It opens up the possibility of affecting other important physiological processes as well. Beyond proliferation and / or promotes cell infiltration and metastasis. In this study, there are some orthogonalities processes and genetically engineered mouse fashions to expose that TGF- β signaling performs a causal position with inside the improvement of diabetes at some stage in PDAC progression. Most notably, we determined that genetic in activation of Smad4 or T β RII with inside the KrasG12D mouse version of human PDAC changed into enough to suppress PDAC-mediated diabetes. Likewise, immunoneutralization of TGF- β in vivo nearly absolutely blunted PDAC-mediated diabetes, implicating TGF- β signaling as a likely goal for attenuating diabetes in pancreatic most cancers patients.

Can pancreatic duct obstruction and consequent pancreatic atrophy cause PCDM?

Long-term diabetes (DM) slightly increases the risk of PDAC, but there is increasing evidence that PDAC often causes DM. Up to 85% of PC patients have DM or hyperglycemia, which often appears 2-3 years before cancer diagnosis. Conversely, patients with newly developed DM are more likely to have a PDAC diagnosis within 13 years of starting DM (58 times the general population). Resection of the PDAC leads to improvement of DM. Type 2 DM is caused by beta-cell damage after decades of obesity-related insulin resistance. Similar to type 2 diabetes, beta cell dysfunction and peripheral insulin resistance are observed in PDAC-induced DM (PCDM). However, in contrast to type 2 diabetes, the onset and progression of impaired glucose tolerance in PCDM occurs in the face of persistent, often severe weight loss. Weight loss precedes the onset of DM on a PC and occurs months before the onset of cancer cachexia. Studies have shown that PC is associated with severe insulin resistance that disappears after PC resection. However, if the frequency of DM is very high, it indicates that there is a dysfunction associated with beta cells. There are many hypotheses about how PCDM can cause DM. a) Is PCDM only 2 DM? Standard risk factors for DM (age, BMI, and family history of DM) are also risk factors for PCDM. However, the fact that newly developed DM and hyperglycemia occur in 85% of PDACs suggests a PDAC-specific stressor that does not deeply and consistently compensate for glycemic homeostasis. b) Can PCDM be the result of the severe cachexia found on PDACs? Cachexia is associated with insulin resistance and can decompensate adhesive homeostasis, especially in the elderly. This is unlikely to be described as PCDM. c) Can pancreatic duct obstruction and consequent pancreatic atrophy cause PCDM? PDACs are often associated with obstructive pancreatitis and distal atrophy. However, the onset of DM occurs when no mass is seen on CT. In addition,

insulin levels in DM patients are expected to be low due to the destruction of islet masses. Insulin levels are relatively high in PCDM, which reflects insulin resistance. The most likely reason for the frequent occurrence of DM on PDACs is the paraneoplastic phenomenon caused by tumor secretions.

DM may be a biomarker for asymptomatic PDAC

Apart from the clinical and epidemiological evidence above, this assumption is supported by experimental data that supernatants from PDAC cell lines inhibit insulin secretion. Much needs to be learned, but new knowledge has recently emerged about the etiology of these metabolic changes in the PDAC. Adrenomedullin, which is overexpressed in PDAC, has been identified as a potential mediator of beta-cell dysfunction in PCDM. Adrenomedullin is a pluripotent hormone with homology similar to amylin. In the pancreas, its receptor is found on beta cells and its expression is specifically observed on islet F cells. Insulin secretion inhibition in beta cells induced by supernatants from PDAC cell lines was replicated by external addition of adrenomedullin and was nullified by its gene knockdown. Similar effects were observed in sympathetic and subcutaneous in vivo tumor models using adrenomedullin-expressing PDAC cell lines. In addition, plasma adrenomedullin levels were higher in PC than in controls, and even higher levels were observed in PCDM. Overexpression of adrenomedullin was observed in surgically resected PC specimens. These data strongly support the belief that adrenomedullin mediates beta cell dysfunction. The causes of insulin resistance and PCD-related weight loss remain unknown, but they also appear to be paraneoplastic phenomena. The PDAC is connected to DM's unique mechanism. The onset of DM occurs in 20-25% of patients 6-365 months before PC diagnosis. At this point, the patient is otherwise asymptomatic. This suggests that the new DM may be a biomarker for asymptomatic PDACs.

However, the strategy of using the new DM as a marker for asymptomatic PDACs will only succeed if PCDM can be distinguished from the more common type 2 diabetes. Identifying

PCDM mediators may lead to the discovery of new biomarkers for PDACs [12].

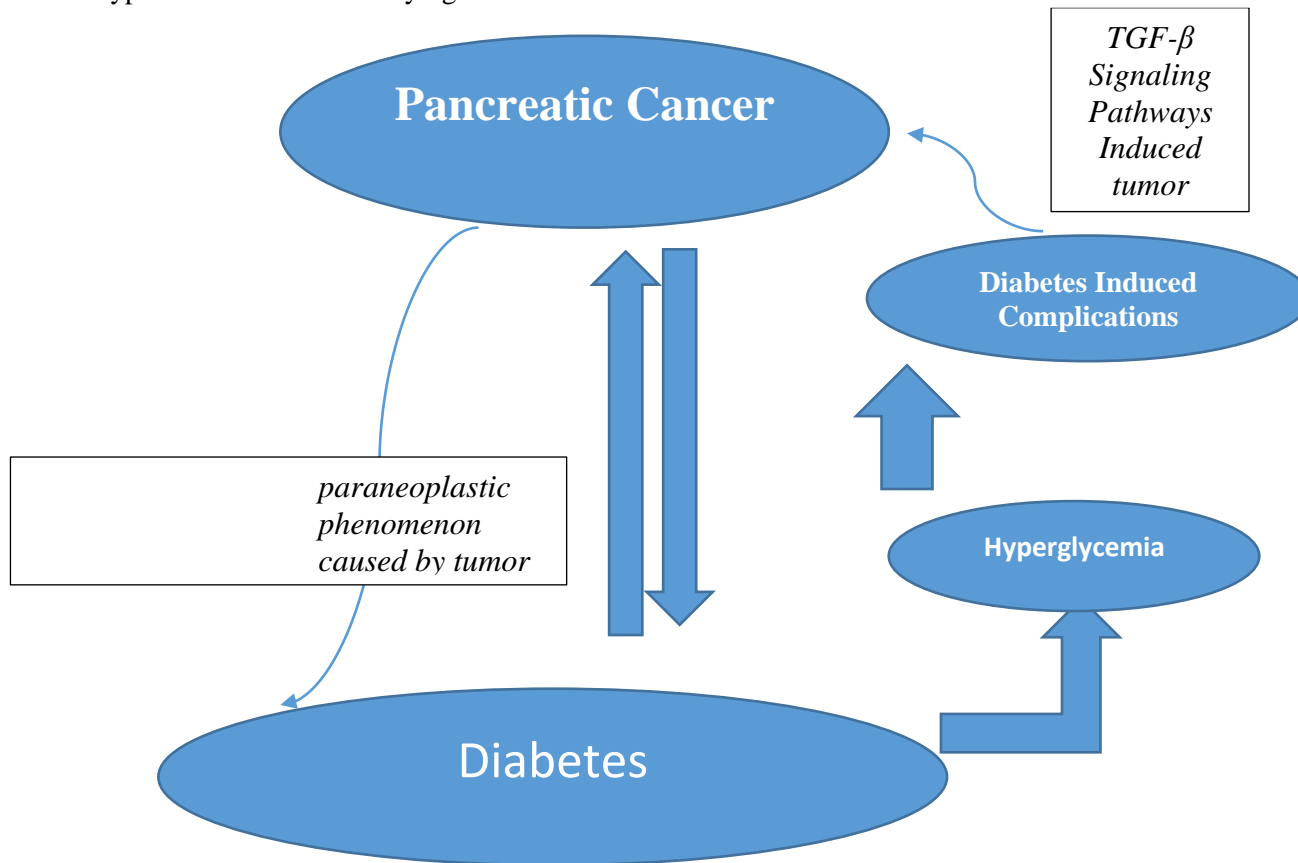


Figure 1: Representing the pathogenesis of the disease and the implicated pathways involved.

Conclusion

Developing an effective strategy to inactivate TGF β is an important therapeutic goal for restoring insulin levels required for normal activity and quality of life and ultimately extending the lifespan of PDAC patients. However, given the paradoxical role of the TGF β signaling pathway as a tumor suppressor and tumor promoter during cancer progression, the TGF β signaling pathway uses an inducible genetic model and an integrated proteome and single-cell sequencing approach. A complete understanding of how PDAC works is a

prerequisite. Whether they antagonize this pathway is useful in the treatment of diabetes if its tumor suppressor properties may co-exist. Such extensive studies may also lead to the identification of components of the TGF β pathway that function only in β -cells and may explain why the TGF β pathway selectively drives β -cell apoptosis.

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