

Radiological Modalities and Diabetes: A Review

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ABSTRACT

Diabetes has become a health care problem of increasing concern in the world as number of individuals with disease are on the rise over the past 2 decades. Imaging technologies are noninvasive tools which are currently receiving an increase significance to guiding physician in finding and therapeutic treatment of patients. Advanced imaging has upgraded our ability to assess the prospect of diabetics in patients. However, the capacity of imaging to detect the existence of osteomyelitis and myotitis does not automatically mean that it should be employ on a regular basis for tentative diagnosis of the diabetics. Diabetes is a multisystemic disease that exerts its effects through decrease insulin sensitivity causing various stages of metabolic conditions. The Pathogenesis of the complication related to diabetes is solely depended to duration of the disease with other health challenges which are refer to co-existing factors. The effects of long-standing effect of diabetes are usually associated with microvascular disease resulting to diabetic retinopathy nephropathy and cardiomyopathy. However, imaging performs an important part in diagnosis and follow-up of associated complications. This paper reviews the pathophysiology of diabetics, discuss the imaging appearance and provide detail review of the diagnostic image profile of patient with diabetics.

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Introduction

Diabetes mellitus (DM) is currently a main health and economic delinquent of the whole world. Diabetes mellitus is a communal disorder that affects high number of individual and results to various medically overwhelming and costly end-organ difficulties [1]. The current risk of patient death due to diabetes are roughly twice higher than that of the non-diabetic medically related diseases [2,3]. According the International Diabetes Federation (IDF), reports about 230 millions of individual will be diagnosed with DM by 2025, within the age of 40 – 60 years [4]. However, DM is ascribed as a metabolic disorder of many aetiology, associated with chronic hyperglycaemia, with alteration in macromolecules metabolism resulting from defects in insulin secretion. Although two categories of diabetes. The Non-insulin dependent DM (type II) associated with insulin resistance in peripheral tissues and insulin is secretory imperfection of the beta cells. While type I are less frequent type with gestational diabetes, drug induced diabetes mostly related to genetic defect [5]. This review is aims at highlighting the current diagnostic appliance in imaging modalities in diagnosis of DM and its complication. In addition to the review of the advances in the use of non-invasive imaging tools which represent new frontier of diagnostic imaging and managing patient with DM.

Diabetic Complication

The classis clinical signs are hyperglycaemia are polyuria, polydipsia, polyphagia, body weight loss and blurred vision [6,5]. However, early exposure to hyperglycaemia has the latent to hasten the development and severity of vascular complication [7]. The complication arising from DM is either acute or chronic in form, the acute form is most due to metabolic derangement ad sever hyperglycaemia. In addition, to the micro and macrovascular complications [8]. The microvascular complication includes nephropathy, retinopathy and neuropathy, while macrovascular includes coronary heart, cerebrovascular incidence. Stroke is also another great complication resulting from DM due to cardiovascular alteration particularly among young subject patients. DM is reported to increase stroke and dementia due brain section damage. In the recent [9]. Digital angiography is still consider as the gold standard for the evaluation of carotid stenosis, Although, a non- invasive techniques (Doppler ultrasound, MRI and CT scan) is commonly use to assess the condition, the luminal stenosis is assessed beyond plaque alteration but to the level of the revascularization of carotid artery. In addition to the B-mode ultrasound used in the detection of the vulnerable plaques carotid MRI, and nuclear imaging techniques all promising accurate diagnostic quality. Charcot neuroarthropathy (CN) is also another

epidemic impediment of DM in which imaging plays a vital role in the early and accurate diagnosis of CN, and in distinction of CN from osteomyelitis [10]. Conventional radiography, computed tomography, nuclear medicine scintigraphy, magnetic resonance imaging, and positron emission tomography are the imaging modalities currently in use for the detection of CN but modalities other than magnetic resonance imaging appeared to be as corresponding well in the early diagnosis of the CN [11].

Diagnostic Imaging Approaches

X-ray

X-ray as a diagnostic imaging has been employed in medical science for many years, it is within the last 40- 50 years that modalities has made a great impact in medicine due to development of different modalities. Images used in medical section routinely roughly categorized into structural and functional imaging categories. The structural has to do with the morphological features of the tissues. While the Computed tomography (CT), magnetic resonance imaging (MRI) and ultrasound (US) modalities are mostly used non-invasive technologies for employed for medical diagnosis of diseases. It was reported by several clinicians that structural imaging alone is not sufficient to provide details of features in a disease that will aid diagnosis [12,13]. Thus, functional imaging has come into used many by multitude, quantitative imaging techniques that are recently used to evaluate tissue, molecular reactions and metabolic pathways [14,15]. However, the advances in specific contrast agents helps in the improved signal to noise ratio acquired on the images from structural information during the same scan sequence or within the same modality [16]. Functional imaging is attained through the use of CT, MRI, and US as well as positron emission tomography (PET) and optical imaging [17]. Additional information and details from structural imaging do help in determining the nature, precise position and extent to disease occurrence and serve as guide towards monitoring therapeutic effects [18-20]. An exemplary demonstration was seen in X-ray where quantitative and qualitative assessment of the bone can be made in diabetic patient to demonstrate cortical thickness of the long bone with great possibility to monitor the bone mass density in the patients [21,22]. Accuracy of the visual display of the structural morphology of the patient is a critical goal of every clinician for several years in science, Although, this fact is often ignored in DM patients [14]. Nevertheless, the rapid increase in the prevalence of DM to 382 million individuals worldwide over the last 20 years and the expected increase to above 500 million in 2030, however, the global consequences requires paradigm-shift approaches to detect, treatment monitoring and prevention [23,24]. It was observed that over a long term, hyperglycaemia can result to serious diseases upsetting the cardiovascular system, kidney, nerves eyes and teeth. In addition, patient with DM have the tendency to developing cognitive impairment, infections and dementia and limb amputation [25]. A short evaluation of the most used modality in diagnostic imaging can be of help in the assessment of the approaches justifying advanced research with a view in both present used and future clinical application [14,25]. X-ray planar radiographs are comparatively inexpensive and gladly available although their sensitivity is quite poor and false negative results are not so rare, particularly in the first stage of osteomyelitis [26].

CT Scan

Computer tomographic scan comprises of an X-ray transient through the object where a portion of the x-rays are either absorbed or scattered by the internal structures and organs, and the residual ray's pattern are conveyed to a rotating detector along multiple linear paths to create cross-section images of the body [27].

However, potential risk indicator of DM is associated with obesity and severe pancreas alteration that can be detected on the patient through imaging and diagnostic history [28,29]. The volumetric evaluation of the pancreatic changes that occur in DM is assessed with MRI CT scan radiological modalities [30]. It was reported that pancreas volume decreases with DM duration in the patient with CT scan modality evaluation [31]. The fatty infiltration on the pancreas secondary to the atrophy of the pancreatic parenchyma is often clearly assess with CT scan modality [32]. Since pancreatic ductal disease are better detected with MRI cholangiopancreatography which is a noninvasive imaging modality for evaluating patient with DM. Microangiopathy induced by the DM in type I can be detected with CT scan on patient with DM type I with patient showing subsegmental, lobar consolidation of the pleural effusion and tubercular pneumonia and lung abscess [33]. It reported arteriosclerosis and atherosclerosis and cerebrovascular stroke are all complication of DM which are detectable using non contrast CT scan of the head of the patient with DM [34].

Magnetic Resonance MRI

Magnetic resonance Imaging (MRI) are used robust magnetic fields and pulses of waves to yield cross-sectional images of organs in the body at high resolution. In addition, to all the findings reported earlier, the ischemic demyelination with arteriosclerosis observed in small arteries of the white matter are observed as diffused hypodensity of the white matter specifically with the periventricular region with gray matter on MRI modalities. It observed that MRI was sensitive in detecting white matter demyelination as reveal with hyperintensity on both T2-weighted and T2-FLAIR images on DM patients [35,36].

Ultrasound Imaging (US)

Ultrasound imaging or US is an imaging technique that uses high frequency of sound waves (1-12 MHz) and their echoes to produce comparatively precise images of structures within the body [37]. US is currently use to detect lipohypertrophy due to glycemic fluctuations associate with DM, since diabetic peripheral neuropathy (DPN) is a common complication with DM which can be diagnosed using US [38,39]. However, high-resolution ultrasound has shown a promising effect on revealing dynamic scan and changes in the morphological alteration in tissue as a result of DM in patient in recent days [40]. This recent advancement with US using a high transducer with a frequently range between 60 – 70 MHz reveal significant tissue minor morphological changes. It mainly includes small nerves ends and results in symmetrical paresthesia and hypersensitivity associated with pain in the early stages of DM. The neuro-ultra sound provides much idea on the nerve size, and echogenicity and mobility of the peripheral structure damage associated with DM. The cross-section area of the nerve with alteration due to DM will reveal a nerve enlargement and blurring honeycomb structure with fuzziness on the boundary of the nerve, since in recent time there is current argument of the use of ultrasound and electrophysiology in the peripheral neuropathy diagnosis in patient with DM [41].

Clinical Applications of Imaging in Diabetes

An overall view of the different non-invasive imaging approaches and their applications on the medical and clinical settings is offered in this section. Some advantages and drawbacks of alternative approaches are often elaborated here in. The role of zinc is critical in the biosynthesis and secretion of insulin is also vital in endocrinology. However, the feasibility of application of zinc-responsive T1 -contrast an MRI for monitoring islet B – cells function in model. Recently two vital approach has been

employed for monitoring of B- cell function using MRI manganese -enhanced and zinc – responsive contrast agents. In addition, the proved of evidence that MRI are useful in the diagnosing and monitoring of immune cell infiltration of pancreas in DM patients [42]. It is reported in several studies that PET, MRI and US are employed in trails to evaluating the efficacy of different imaging modalities for visualizing transplanted islets. In DM patient renal function is deteriorated as a result, heterogeneous structural changes occur in many stages [14]. The dimmish size changes that occur can be detected with US imaging for typical assessment of kidney size variation. It was also reported that US dopplers can provide both evaluation of the renal parenchymal perfusion and the computation of renal resistance parameters to assess endothelial dysfunction and microvascular impairment in the kidney of DM patients [43]. Quantitative diffusion -weighted MRI can also performance a vital role in the evaluation of renal diseases associated with DM patients [44]. MRI is also another best tools for the brain atrophic areas in both gray and white matter specific cerebral areas in type 2 diabetic patients, with several studies showed a significant correlation between T2D and brain infarct, mostly lacunar necrosis and in nephropathy [45]. Cerebrovascular reactivity, assessed by MRI or transcranial Doppler US to quantify microvascular reserved [46].

The evaluating of the pancreatic islet and beta cell imaging by non-invasive imaging modalities the severity and the extend of a critical mass of B cells destruction could pointedly aid in the diagnosis and treatment of diabetes [46]. However, imaging of B cells is a key challenge due to the small size of the pancreatic islets, the low-density distribution of islets throughout the pancreas, the scare inherent contrast from the surrounding tissue [47]. Several diagnostic imaging techniques has recently been tested in the study of B cells diseases. It is very common that diabetes mechanism result to cardiomyopathy due to fat accumulation in myocardial tissue [48]. MRI spectroscopy is as well suitable to access the effect of pharmacological regimes of DM on intra-myocardial triglyceride accumulation [49]. Diabetic myopathy is reported frequently in patient with type -2 diabetes exposure to T2 weight and contrast-enhanced images with similar images and increased coexistence of nephropathy when gadolinium-based contrast is administered [50].

Conclusions

DM neuropathy, nephropathy, and retinopathy are all widely recognized sequelae of DM; and as the prevalence of DM increases, a number of important complications affecting the muscles, spinal cord, and feet are being observed more frequently. However, many of these circumstances have clinical structures that overlap, resulting in diagnostic dilemmas, imaging plays a crucial role in accessing and distinguishes among them. The article reveals salient features of DM musculoskeletal and neurological conditions that commonly occurs as complications of DM and offers guidance for arriving at an precise diagnosis based on clinical and imaging manifestations.

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