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EDITORIAL

Dento-maxillofacial radiology as a specialty

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Abstract

This editorial discusses a relatively new specialty in dental and medical field namely dentomaxillofacial radiology. As a relatively newborn specialty it is obvious that there is a long way to go before dentomaxillofacial radiology is commonly known and respected by the society. All over the world, assigned committees work on the development of the training curriculum, determination of scientific and physical standards for institutions offering specialty training and arrangement of dental codes for reimbursement issues. Furthermore, adjustment of educational, scientific and legal regulations and prospective benefits are expected to boost this specialty's attractiveness to colleagues' worldwide.

Key words: Dentistry; Dento-maxillofacial radiology; Specialty

Core tip: Dento-maxillofacial radiology is one of the dental specialties recognized under different names and divisions by around forty countries in the world. It includes, intra-oral imaging, dental panoramic imaging, cephalometric imaging, sialography, cone beam computed tomography (CT), multislice medical CT, ultrasonography, magnetic resonance imaging, positron emission tomography and nuclear medicine. All over the world, assigned committees work on the development of the training curriculum, determination of scientific and physical standards for institutions offering specialty training and arrangement of dental codes for reimbursement issues.

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DENTO-MAXILLOFACIAL RADIOLOGY AS A SPECIALTY

Dento-maxillofacial radiology is one of the dental specialties recognized under different names and divisions by around forty countries in the world. Diagnostic imaging techniques have always been a tremendous asset in clinical dentistry. Since the early 1900s, dental faculties in developed world have been engaged in teaching Oral Radiology[1]. It includes, intra-oral imaging, dental panoramic imaging, cephalometric imaging, sialography, cone beam computed tomography (CBCT), multislice medical computed tomography, ultrasonography (US), magnetic resonance imaging (MRI), positron emission tomography and Nuclear Medicine. Also, application of computer aided and image guided procedures with Haptic and Robotic devices are in progress[2]. In addition, visible light, optical coherence tomography, and terahertz imaging are other methods in use or under development[3,4].

Intraoral imaging, continues to provide the best spatial resolution of any imaging method currently available. Also, panoramic radiography is a commonly used two-dimensional technique which gives the broad view of both jaws without the detail offered by the intraoral images. In response to the high demand for a technique that could provide three-dimensional data at a lower cost and with lower radiation doses than the conventional computed tomography used in medical radiology, CBCT was developed specifically for dento-maxillofacial imaging. A spate of revolutionary CBCT applications reached the dental market in the 2000s, marking the beginning of a new era in the field of dento-maxillofacial radiology. New technological specifications and settings include multiple field of views and voxels that can better address a variety of specific tasks. There are also several hybrid machines offering CBCT imaging along with panoramic and cephalometric radiography. CBCT has come into common use for a variety of purposes in the fields of endodontics, dental implantology, dento-maxillofacial surgery and orthodontics[5].

On the other hand, scientists have also been searching for safer and comparable alternative imaging modalities to X-ray imaging due to increasing concerns regarding radiation dose and economic limitations. In this context, MRI and US were introduced and now widely utilized for a variety of tasks in medicine. MRI is a powerful and versatile imaging modality and most work in the field of dental MRI aimed at imaging soft tissues and imaging of the morphology and function of the temporomandibular joint[6]. Recent development of the US equipment enables the visualization of fine detail of the surface structure of the oral and maxillofacial tissues without the use of ionizing radiation. In the field of dentistry, US technique can be used in clinical practice for bone and superficial soft tissue examination, major salivary gland or duct stone and salivary gland lesion detection, temporomandibular joint imaging, detection of fractures and vascular lesions, lymph node examination, measurement of the thickness of muscles and visualization of vessels of the neck including the carotid for atherosclerotic plaques. More recently, development of three-dimensional US imaging allowed multiplanar reformatting, volume rendering and color power doppler (CPD). In endodontics, CPD is used in the evaluation of periapical lesions and follow up of periapical bone healing and for differentiation between vital and root filled teeth. US imaging is also used to guide fine-needle aspiration biopsy in the neck with the advantage of low cost, ease of usage and radiation safety. Ultrasound provides a number of advantages for dento-maxillofacial imaging when compared to other advanced imaging modalities such as; absence of harmful ionizing radiation, portability, possibility of dynamic and repeated examinations and relatively low cost[7].

Depending on the imaged area, diagnostic images obtained from the dento-maxillofacial region may show part or the entire nasal cavity, paranasal sinuses, airway, cervical vertebrae and temporal bone. Finally, even when scans are taken for primarily unrelated reasons, assessment of the all imaged area, should always be performed in order to rule out any significant pathological changes. Incidental findings require follow-up, and further treatment options may be identified in conjunction with clinical findings, including referral to a specialist not directly linked to the field of dentistry, where appropriate.

As a relatively newborn specialty it is obvious that there is a long way to go before dento-maxillofacial radiology is commonly known and respected by the society. All over the world, assigned committees work on the development of the training curriculum, determination of scientific and physical standards for institutions offering specialty training and arrangement of dental codes for reimbursement issues. Furthermore, adjustment of educational, scientific and legal regulations and prospective benefits are expected to boost this specialty’s attractiveness to colleagues’ worldwide.

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REVIEW

"To-and-fro" waveform in the diagnosis of arterial pseudoaneurysms

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Abstract

Medical ultrasound imaging with Doppler plays an essential role in the diagnosis of vascular disease. This study intended to review the clinical use of "to-and-fro" waveform at duplex Doppler ultrasonography (DDU) in the diagnosis of pseudoaneurysms in the arterial vessels of upper and lower extremities, abdominal aorta, carotid and vertebral arteries as well as to review our personal experiences of "to-and-fro" waveform at DDU also. After receiving institutional review board approval, an inclusive literature review was carried out in order to review the scientific foundation of "to-and-fro" waveform at DDU and its clinical use in the diagnosis of pseudoaneurysms in various arterial vessels. Articles published in the English language between 2000 and 2013 were evaluated in this review study. Pseudoaneurysms in arterial vessels of the upper and lower extremities, abdominal aorta, carotid and vertebral arteries characterized by an extraluminal pattern of blood flow, which shows variable echogenicity, interval complexity, and "to-and-fro" flow pattern on color Doppler ultrasonography. In these arterial vessels, Duplex ultrasonography can demonstrate the degree of clotting, pseudoaneurysm communication, the blood flow patterns and velocities. Spectral Doppler applied to pseudoaneurysms lumen revealed systolic and diastolic turbulent blood flow with traditional "to-and-fro" waveform in the communicating channel. Accurate diagnosis of pseudoaneurysm by spectral Doppler is based on the documentation of the "to-and-fro" waveform. The size of pseudoaneurysm determines the appropriate treatment approach as surgical or conservative.

Key words: Pseudoaneurysm; To-and-fro waveform; Ultrasonography; Percutaneous thrombin injection; Yin-Yang sign

Core tip: A review of the clinical use of "to-and-fro" waveform at duplex Doppler ultrasonography (DDU) in the diagnosis of pseudoaneurysms in the arterial vessels of upper and lower extremities, abdominal aorta, carotid and vertebral arteries as well as to review our personal experiences of "to-and-fro" waveform at DDU also.

Mahmoud MZ, Al-Saadi M, Abuderman A, Alzimami KS, Alkhorayef M, Almagli B, Sulieman A. "To-and-fro" waveform in the diagnosis of arterial pseudoaneurysms. *World J Radiol* 2015; 7(5): 89-99 Available from: URL: http://www.wjgnet.com/1949-8470/full/v7/i5/89.htm DOI: http://dx.doi.org/10.4329/wjr.v7.i5.89

INTRODUCTION

A pseudoaneurysm is defined as an arterial wall deficiency, which leads to accumulation of oxygenated blood in the nearby extra-luminal region. Therefore arterial blood spread out of the vessel, forming a sac surrounding by soft tissue and compressed thrombus[1]. Consequently, a pseudoaneurysm is formed as a result of fibrin wall formation nearby the swelling[2]. The basic difference of arterial aneurysm and pseudoaneurysm is that the three-layers of the arterial wall don't bind the later one[3]. Pseudoaneurysms which are the most common in the femoral and radial arteries, often noticed in the groin and forearm after cardiac catheterization. Furthermore, it may observe also after arterial punctures of blood gas analysis, after the placement of indwelling catheter or after direct arterial trauma[2-5].

Ultrasonography (US) has been widely utilized as a noninvasive imaging modality for the investigation of vascular diseases[6-9]. US which is a valuable tool for diagnosis of pseudoaneurysms has been widely utilized as a noninvasive imaging modality for investigation of vascular disease. The main advantage of US imaging is no use of ionizing radiation, cheap, and availability[10,11]. It has been reported that US has 94% and 97% of sensitivity and specificity, respectively in the diagnosis of postcatheterization pseudoaneurysms, but this sensitivity is not enough to diagnose the pseudoaneurysms of the deep visceral arteries[12,13]. The major limitation of US it is an operator dependent imaging technique, has low sensitivity in the evaluation of deep visceral artery pseudoaneurysm, and evaluation of vessels in trauma patient accompanied with hematoma or fracture[14].

In pseudoaneurysms, Analog US images (grayscale) usually illustrate hypoechoic cystic structures nearby a supplying artery[15,16]. Grayscale can be used to evaluate many pseudoaneurysmal findings such as the size, the number of pseudoaneurysm, and its relation to the artery[17]. However, grayscale is not a conclusive evidence in diagnosis pseudoaneurysm because its findings are accompanied by other clinical conditions such as hematomas and cystic masses either simple or complex[1].

Therefore, Doppler US can be used to confirm the diagnosis. In addition to that, blood flow in a cystic structure distinguished by swirling motion pattern "yin-yang sign". Also, this type of flow can be detected in saccular aneurysm. Therefore, differential diagnosis is essential for pseudoaneurysm. The cornerstone of pseudoaneurysm diagnosis is dependent upon the appearance of the communicating neck between the arterial vessel and pseudoaneurysmal sac with "to-and-fro" waveform at duplex Doppler ultrasonography (DDU). The "to" represents the arterial blood going into the pseudoaneurysmal sac in systolic cycle, while "fro" illustrate blood exiting the sac in diastolic cycle[18].

In this article authors review the clinical use of "to-and-fro" waveform at DDU in the diagnosis of pseudoaneurysms in various arterial vessels, as well as our personal experiences of "to-and-fro" waveform at DDU in the Radiology Department of King Fahad Medical City (KFMC) at Riyadh, Saudi Arabia.

LITERATURE SEARCH

After receiving institutional review board approval, an inclusive literature review was carried out in order to review the scientific foundation of "to-and-fro" waveform at DDU and its clinical use in the diagnosis of pseudoaneurysms in various arterial vessels of the upper and lower extremities, abdominal Aorta, carotid arteries and vertebral arteries.

The ScienceDirect, PubMed, MEDLINE, NCBI and SAGE database were searched in April 2014 for publications containing information about "to-and-fro" sign in the diagnosis of pseudoaneurysms in various arterial vessels in the title of the report. Abstracts resulting from this search were reviewed for relevance to the clinical outcomes from the procedure. Full manuscripts were retrieved and reviewed if they contained information regarding the evaluation of the evidence on the role of "to-and-fro" sign in the diagnosis of pseudoaneurysms and the published clinical literature in this field.

Only those papers published between 2000 and 2013 were included in the outcomes analysis, and this was due to the tremendous development in this medical diagnostic specialty at the beginning of the new millennium so far. Regarding place of the study or journal type in order to include all available sources of experience.

GENERAL SONOGRAPHIC FEATURES REGARDING ARTERIAL PSEUDOANEURYSMS

US is a readily available imaging modality, which does not expose the patient to ionizing radiation. Grayscale and color Doppler techniques are utilized, and standardized protocols in an accredited ultrasound laboratory will increase the likelihood of detection of pseudoaneurysm. Grayscale is often initially performed. Linear (high frequency) US probe has acceptable depth penetration and visualization should be used. After a general overview of the area of concern, attention should be given to any anechoic collections or regions of hematoma[19].

Color Doppler is placed in any anechoic collection to detect flow. The flow can be characterized if the scale is properly set to avoid aliasing due to under sampling. Spectral Doppler is then performed if flow is detected to help characterize arterial *vs* venous flow. Spectral waveforms may be diagnostic of the pseudoaneurysm and help to exclude arteriovenous fistula (AVF). A low wall filter may be initially used to detect slow flow, and the waveform should fill at least two-thirds of the spectral window. In grayscale, a patent pseudoaneurysm appears as an anechoic rounded or ovoid structure. Because other fluid collections, including cysts, seromas, or hematomas can have this appearance, color Doppler imaging is used to confirm the presence of blood flow within the pseudoaneurysm. When present, thrombus in the pseudoaneurysm appears mildly echogenic or hypoechoic without flow; it may be mural or centrally fill a portion of the pseudoaneurysm lumen[1]. Turbulent blood flow is illustrated by interchangeable coloring appearance, either in red or blue color. If large areas of color aliasing are identified in the adjacent tissues, grayscale may help to differentiate pseudoaneurysm from tissue reverberation associated with AVF[19].

The scientific foundation of "to-and-fro" waveform at DDU and its clinical use in the diagnosis of pseudoaneurysms in various arterial vessels, could be discussed on the basis that, the DDU monitoring will present the conventional "to-and-fro" waveform with blood flow of the bidirectional pattern at the neck of pseudoaneurysm. Occasionally, the neck is the only patent portion of the pseudoaneurysm if partial thrombosis has occurred[19].

INCIDENCE OF PSEUDOANEURYSM IN THE PERIPHERAL ARTERIES, ABDOMINAL AORTA AND NECK ARTERIES

The incidence of pseudoaneurysms has increased in hospital based practice, due to the large number of invasive procedures performed[20]. Their incidence varies in the literature due to different definitions, methods of interrogation and presence of certain complications[21]. According to medical literature, the incidence of pseudoaneurysms ranges from 0.1% to 6% and up to 0.5% to 9%, depending on the diagnostic or therapeutic procedure performed[22,23].

The frequency of peripheral arteries pseudoaneurysms is much less in the upper extremities than in the lower extremities (less than 2% of all lesions)[24,25]. Aortic pseudoaneurysms are rare, life-threatening sequelae of cardiac surgery[26]. The incidence, risk factors, and natural history of aortic pseudoaneurysm are unknown, because so few cases have been reported[27]. Pseudoaneurysms of the abdominal aorta are rare, especially those found to be mycotic. Abdominal aorta pseudoaneurysms following trauma have been reported fairly often[28]. Common carotid artery pseudoaneurysms are rare and potentially lethal, and adequate treatment is warranted in order to prevent rupture or neurologic sequelae[29]. Vertebral arteries pseudoaneurysm formation after central line placement has been well documented in the literature, with an incidence rate of 0.05% to 2%[30,31].

AETIOLOGY OF PSEUDOANEURYSM IN THE PERIPHERAL ARTERIES, ABDOMINAL AORTA AND NECK ARTERIES

Iatrogenic complication

Unintentional pseudoaneurysm due to surgical intervention for numerous medical procedure (*e.g.*, pseudoaneurysm can be induced in femoral artery during cardiac catheterization). It accounts up to 70%-80% of the incidence of pseudoaneurysms[32].

Trauma

It had been estimated that 79% of pseudoaneurysms are traumatic in origin of the internal solid organs such as liver, kidneys, pancreas, and gastrointestinal tract of the digestive system[33].

Injury by tumor

Pseudoaneurysm can be initiated due to blood vessel erosion by an erosive tumor, either benign or malignant. This is most commonly seen in osteochondroma, neurofibromatosis, leukemia, and lymphoma[34]. Yang *et al*[35] reported that 25% of pseudoaneurysms are caused by neoplastic aneurysms as choriocarcinoma. Kim *et al*[36] also reported leukemia and lymphoma as a cause of pseudoaneurysm by damaging the arterial vessel wall.

Infection

Pseudoaneurysm can be initiated by primary (wall infection) or secondary (adjacent focus) infection of blood vessels. It has been reported that pseudoaneurysms are more frequent in incidence than true aneurysms, this is because the infection can disturb blood vessels wall more easily[37].

Vasculitis and inflammation

Formation of pseudoaneurysm in blood vessels is caused by destroying the elastic fibers of the media, induced by inflammation. The majority of pseudoaneurysms is caused by Behcet's syndrome, while pseudoaneurysms caused by primary vasculitis are not common in incidence[38].

Atherosclerosis

Aortic pseudoaneurysms are caused by atherosclerotic ulcer due to disturbance of internal elastic lamina, which can lead to aortic rupture or aortic dissection[39].

Infarction

Another cause of pseudoaneurysm is infarction of the left ventricle. It occurs due to separation of the left ventricle free wall enclosed by superimposing adherent pericardium, generated what has been named "pseudoaneurysm of the left ventricle"[40].

MANAGEMENT OF PSEUDOANEURYSM IN THE PERIPHERAL ARTERIES, ABDOMINAL AORTA AND NECK ARTERIES

Surgical approach

The gold stander of pseudoaneurysm treatment in general is surgical intervention. The intervention includes arterial ligation, organectomy either partially or totally, and resection using bypass techniques. Surgical treatment is associated with increased morbidity and mortality as compared with minimally invasive treatment options. The complications associated with surgery include bleeding, infection, lymphocele formation, radiculopathy, perioperative myocardial infarction, and death[41].

Endovascular approaches

Endovascular approaches to therapy offers distinct advantage to conventional surgical repair in patients with visceral pseudoaneurysms[42]. Several endovascular techniques have been described to treat pseudoaneurysms. These techniques include catheter-guided embolization with use of coils or detachable balloons[43,44]. Similar management principles are applied to management of aortic pseudoaneurysms[45]. Compared to other techniques, endovascular procedures have lower morbidity and mortality rate in the management of pseudoaneurysm compared to surgical intervention[19].

Percutaneous approach

Percutaneous US-guided thrombin injection is an important treatment option for the treatment of pseudoaneurysms. This approach appears to be a safe and expeditious method for treating postcatheterization femoral pseudoaneurysms. It has significant advantages with respect to ultrasound guided compression repair or surgical repair[19]. Recently, the percutaneous thrombin injection was introduced for the treatment of iatrogenic pseudoaneurysm of femoral artery[46,47].

In addition to that, this procedure can be used to treat arteries above the inguinal ligament and is considered as an alternative technique to US-guided compression in order to avoid arterial rupture[48]. Complications of thrombin injection are uncommon, occurring in 0%-4% of cases[12]. Most reported complications involve the escape of thrombin into the native circulation, causing distal embolization. This occurs in as many as 2% of all patients treated[41].

US-guided compression

US-guided compression of pseudoaneurysms is a safe and cost-effective method for achieving pseudoaneurysm thrombosis. However, it has been demonstrated that the success rate is higher and procedure time is much shorter for thrombin injection compared with US compression[48]. Furthermore, compression of pseudoaneurysm is painful to the patient and time-consuming for the practitioner. US-guided compression is more likely to fail in a patient with anticoagulation, large pseudoaneurysm size, chronic pseudoaneurysm, and longer procedure time. The incidence of complications is small but they occasionally do occur[19].

TO-AND-FRO WAVEFORM IN PSEUDOANEURYSMS OF UPPER EXTREMITY ARTERIAL VESSELS

The characteristic appearance of pseudoaneurysm in upper extremities arterial vessels is the extraluminal pattern of blood flow, which shows variable echogenicity, interval complexity, and "to-and-fro" flow pattern on color Doppler ultrasonography (CDUS)[49,50]. It has been estimated that 2% to 3% of pseudoaneurysm in Subclavian artery occur due to blunt trauma, or injuries after clavicle fracture[51].

Pseudoaneurysm of radial artery could be caused also as a result of bacterial infection at cannulation site[8]. It has been considered that radial artery pseudoaneurysm is a rare pathological condition accounting and incidence of 0.048%[52].

Rozen *et al*[53] reported that pseudoaneurysm of radial artery are a common finding in patients with anticoagulated or patient under antiplatelet treatment. It's crucial to deliberate pseudoaneurysm diagnosis in any swelling that may presents swelling in order to avoid puncture or incision of the vessel because this swelling could be tender and warm[54].

Several imaging modalities may be used to detect pseudoaneurysms in upper extremity arterial vessels, including conventional arteriography, computed tomography (CT) angiography, radionuclide angiography, and CDUS. US imaging is a diagnostic method of choice required to access pseudoaneurysm before US guided intervention is established for pseudoaneurysm of radial artery[55,56]. CDUS is accurate, noninvasive imaging technique, and widely available. Therefore, it can be used to diagnose pseudoaneurysm of radial artery without even a side effect[51,57,58]. US imaging procedure has the ability to differentiate between solid and cystic lesions adjacent to the radial artery in the wrist area[53]. The sonographic appearance of the

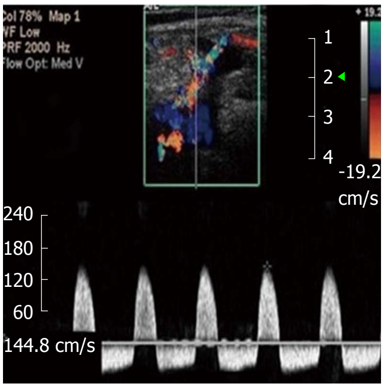

Figure 1 To-and-fro spectral waveform of a pseudoaneurysm; neck wasn't depicted[65].

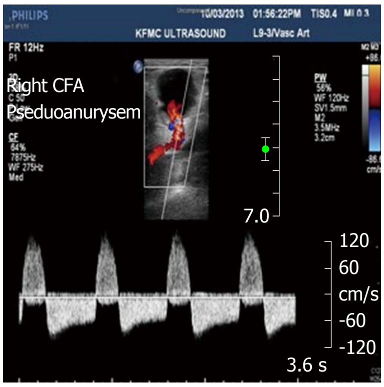

Figure 2 Right common femoral artery pseudoaneurysms associated with the characteristic findings of a pulsatile mass, a palpable thrill, and an audible "to-and-fro" murmur. CFA: Common femoral artery.

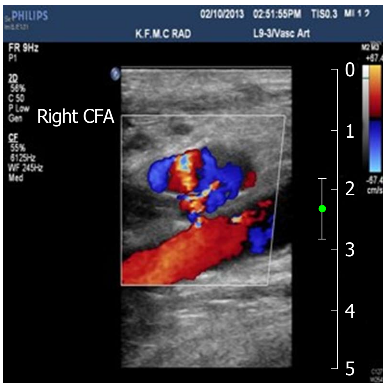

Figure 3 Pseudoaneurysm communicated with the right common femoral artery, and the blood flow patterns and velocities in the affected area. CFA: Common femoral artery.

radial artery characterized by a feature of sonolucent pulsatile tube[59]. Spectral Doppler of the radial artery pseudoaneurysm is usually shown both "yin-yang" sign and "to-and-fro" waveform[51,57,60].

A recent report describes the attempted repair of a brachial artery pseudoaneurysm in an infant that resulted in the thrombosis of the underlying brachial artery and an emergent thrombectomy[61]. The light of the fact that neonates brachial artery injuries are uncommon, but induced by a brachial artery puncture. Therefore, this intervention is not recommended in neonates[62]. In the literature induction of brachial artery pseudoaneurysm due to venipuncture was documented in two instances[63]. Arterial injuries can be diagnosed promptly by using Duplex US imaging technique (Figure 1), without any further need for angiography[64,65]. Also DDU can be up to 95% to 100% sensitive for diagnosing vascular injuries in the hands of highly qualified personnel with a high index of suspicion[5].

TO-AND-FRO WAVEFORM IN PSEUDOANEURYSMS OF LOWER EXTREMITY ARTERIAL VESSELS

The incidence of pseudoaneurysm in lower extremity arterial vessels was estimated to be ranged from 3.5%-5.5% and 0.1%-0.2% of the Interventional examination and diagnostic radiography, in that order[66,67]. Femoral artery pseudoaneurysms are usually accompanied with a certain features of an audible "to-and-fro" pulsatile mass and touchable thrill (Figure 2). Duplex US of femoral artery (Figure 3) is the diagnostic method of choice for the diagnosis of Pseudoaneurysm[67]. This imaging technique can reveal the blood flow waveform, blood clotting, and the relation with the femoral artery[67].

The common femoral artery is the most frequent site of pseudoaneurysm in the lower extremities (Figure 4). This can be attributed to the localization of the common femoral artery inside the neurovascular sheet and it's supported by the head of the femur. Also the common femoral artery site is the place of choice to introduce cardiac catheterization. The incidence of pseudoaneurysm in the superficial femoral artery is less frequent in occurrence when compare with the common femoral artery because this artery is usually not selected for cardiac catheterization as a result of insufficient supportive tissue around it[68,69].

Also popliteal artery is the most frequent region for pseudoaneurysm incidence because this artery is not supported by muscular tissue to shield it from dilatation and bending, compared to superficial and deep femoral arteries[70]. Enlarging and pulsatile mass located in the popliteal artery are the common features of aneurysmal lesion[70,71]. There are a similarity in diagnostic findings between popliteal artery mycotic pseudoaneurysm and other pseudoaneurysms on the basis of CDUS finding[2,72].

Pseudoaneurysms of the anterior tibial artery and tibioperoneal trunk are exceedingly rare[73,74]. Owen *et al*[75] reported that pseudoaneurysms of the tibial arteries can be treated using percutaneous injection of thrombin and tissue adhesive. To prevent sudden incidence of a thrombosis in the native vessel, occlusion balloon can be used. An important study reported by Davis *et al*[76] showed that pseudoaneurysm can be treated with percutaneous infection of thrombin at the posterior tibial and distal superficial femoral arteries. Pseudoaneurysm

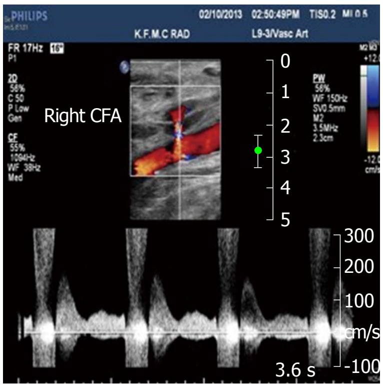

Figure 4 Spectral analysis of the right common femoral artery showing prominent flow with a component of reversed flow, in the region of the neck of the pseudoaneurysm. CFA: Common femoral artery.

can be formed during surgical replacement of the knee joint. This can occur either direct (intra-operative) or indirect (intimal plaque disruption)[77].

Some studies reported that the incidence of pseudoaneurysms or aneurysms are rare in the dorsalis pedis artery and usually accompanied with trauma[78-80]. Surgical intervention is preferred to reduce the risk of complication, such as ischemia, arterial rupture, and thrombosis[80,81].

To differentiate between a hematoma and pseudoaneurysm in lower extremities arterial vessels, DDU can be used to establish the accurate diagnosis by demonstrating the relation between the injured artery and aneurysmal neck[82]. In addition, triplex Doppler US can be used for diagnosis of pseudoaneurysm, by presenting "yin-yang" pattern. Bearing in mind that this pattern don't usually differentiate between pseudoaneurysm and pulsating hematoma[83].

TO-AND-FRO WAVEFORM IN PSEUDOANEURYSMS OF ABDOMINAL AORTA

The incidence of abdominal aneurysms has been established by Ertürk *et al*[84] to be 1% of the overall abdominal aneurysms, concluding that pseudoaneurysms of abdominal aorta has a very low incidence. Pseudoaneurysms of the abdominal aorta are often diagnosed late or after catastrophic complications[85]. Pseudoaneurysms of abdominal aorta caused by medical interventions, these interventions are abdominal surgery, Interventional guided by X-ray imaging of the abdomen, as a complication of abdominal aortic aneurysm, vasculitis, external abdominal trauma, and mycotic aneurysms. Pseudoaneurysms due to external abdominal trauma showed a high incidence in patients treated with anticoagulant or antiplatelet[86].

Shanley *et al*[87] reported that pseudoaneurysms could be developed in the majority of the visceral artery. A different incidence rate was noted in the splenic artery (46%), renal artery (22%), hepatic artery (16.2%), and pancreaticoduodenal artery (1.3%)[88-90]. Those involving the gastroduodenal artery constitute just 1.5% of all published visceral artery aneurysms[90].

Pseudoaneurysms also took place as a result of a combination of an artery impeded with the wall of pseudocysts[91]. Gastroduodenal and splenic artery pseudoaneurysms are silent in the majority of cases, but in some cases, patients may experience upper abdominal pain or anemia due to bleeding in the gastrointestinal tract or peritoneal cavity[92].

Pseudoaneurysms of splenic artery in different patients are caused by pancreatitis, either chronic or acute pancreatitis. The majority of these patients is characterized by a history of excessive alcohol consumption. The main cause of pseudoaneurysms formation by the aforementioned method is due to the digestion of splenic artery by pancreatic enzymes[93]. Pseudoaneurysm development in the splenic artery due to blunt abdominal trauma had been reported by Sugg *et al*[94]. Splenic artery slow blood flow is a predisposing factor of pseudoaneurysm as reported by Norotsky *et al*[95]. In recent year's noninvasive procedure, therefore the incidence of pseudoaneurysm of splenic artery is increasing in incidence among patients[96]. It has been reported that pseudoaneurysm may develop rarely due to peptic ulcer or as a result of iatrogenic causes. An a tiny number of patients developed pseudoaneurysm in the splenic artery without specific reasons[10].

False aneurysms of the gastroduodenal artery can arise from an impairment in the integrity of the arterial wall, by direct injury *via* a biopsy needle, enzymatic digestion, as a result of pancreatitis, surgery, or trauma[97]. This defect can lead to the formation of an open communication between the lumen of the artery and its surroundings, which can have two fates. If no soft tissues surround the site of injury, hemorrhage into the peritoneal cavity can occur. The presence of surrounding soft tissue, conversely, can result in containment of the hematoma, which can be followed by fibrosis and enlargement[98]. Pseudoaneurysms have been reported to spontaneous thrombosis, but this is a rare event occurring only under certain conditions[99]. More often, the hematomas become unstable and rupture, being associated with a mortality rate of around 50%[100].

Diagnosis of gastroduodenal and splenic pseudoaneurysm can be made with a number of imaging methods. Contrast-enhanced CT and Doppler sonography are widely used as noninvasive techniques in the diagnosis and monitoring of the lesion[101,102]. On contrast-enhanced CT, a pseudoaneurysm appears as an eccentric mass with a well-defined region of central enhancement in the arterial phase. Doppler sonography shows a mass that generally has a well-defined, solid peripheral component composed of a thrombus and a central anechoic area of varying size. This cavity fills on color Doppler imaging and produces the typical "yin-yang" pattern of pseudoaneurysms anywhere in the body. A "to-and-fro" pattern at the neck of the lesion is confirmatory of a pseudoaneurysm.

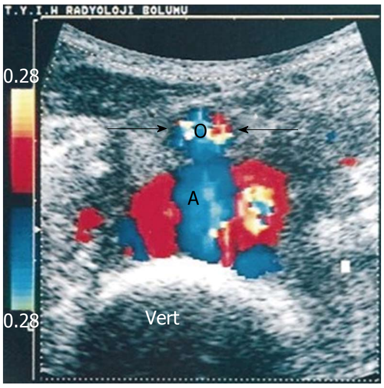

Figure 5 Transverse color Doppler sonogram shows turbulent flow in the pseudoaneurysm. Note the anterior displacement of the normal-sized aorta (arrows and AO) and the drape of the posterior wall of the pseudoaneurysm over the anterior aspect of the spine (vert)[84].

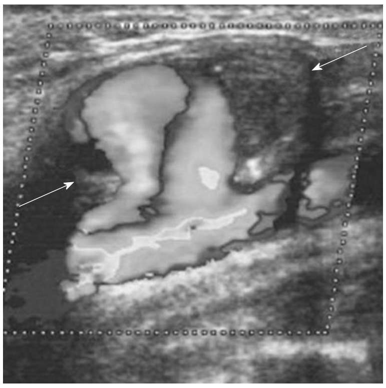

Figure 6 Color Doppler sonogram showing the blood flow of the right common carotid artery, and the haematoma with the rotatory flow within its cavity (arrows). Note the large neck connecting the carotid to the pseudoaneurysm[90].

Angiography remains the definitive modality used to diagnose, locate, and evaluate the presence of a gastroduodenal and splenic pseudoaneurysm[101,102]. The advantage of this method is that it can be used in the treatment of the lesion as well. Angiography is useful in establishing confirmation of the diagnosis and in cases of an acute rupture or major gastrointestinal bleeding requiring immediate care[93]. The sonographic appearance of abdominal aortic pseudoaneurysm is anechoic blood accumulation in a sac nearby within the artery. This accumulation can be detected by using color Doppler[84]. Sonographic examination of patient using color duplex Doppler revealed a pattern of turbulent flow within pseudoaneurysm illustrated in (Figure 5). Whirlwind flow and "to-and-fro" waveform are seen in the neck of pseudoaneurysm also by using pulsed Doppler[103].

The limitations of color duplex Doppler in the diagnosis of pseudoaneurysms are obese patients and the presence of excessive gasses in the bowel. Neverless ultrasound should be used to establish preliminary diagnosis, especially for patient with pulsatile abdominal masses[84,104].

TO-AND-FRO WAVEFORM IN PSEUDOANEURYSMS OF CAROTID AND VERTEBRAL ARTERIES

Carotid and vertebral artery pseudoaneurysms are uncommon lesions that may occur as sequelae of blunt trauma, cancer or radiation necrosis, and mycotic infection[104]. Although Doppler ultrasound is a noninvasive imaging procedure, more accurate imaging modalities have been developed such as magnetic resonance angiogram or angiography. However US is the imaging method of choice (Figure 6) to study the midcervical portion of the carotid or vertebral arteries[105-107].

The degree of confidence is high in detection carotid (mid cervical region) and vertebral artery pseudoaneurysms. While the degree of confidence is low in the detection of an intrathoracic segment of the carotid and vertebral arteries[108].

Duplex ultrasound is used on a routine basis to evaluate atherosclerotic lesions. The main findings include dissection, occlusion, pseudoaneurysms, and intimal flaps. Nemours studies used DDU reported that around 92%-100% sensitivity in detection of arterial lesions due to neck trauma[109-111]. The contour of pseudoaneurysms affecting carotid arteries showed variable color flow, depending on the presence of thrombosis[112], while swirling blood flow and "to-and-fro" pattern is shown by spectral Doppler[113]. In common carotid arteries, ultrasound is an effective means of diagnosing a pseudoaneurysm. It may also be used for serial follow the progression of these occurrences once they are diagnosed, as well as to aid in treatment in certain cases[114]. When investigated internal carotid artery pseudoaneurysm by color Doppler it shows swirling of blood flow within the pseudoaneurysm with a communicating channel of the parent artery (yin-yang phenomenon), while pulse Doppler shows "to-and-fro" waveforms[115].

Vertebral artery pseudoaneurysms typically present over the course of several days as a pulsatile mass. Duplex US is used to define the size of the pseudoaneurysms. Adequate visualization of the pseudoaneurysms neck of lesions arising vertebral arteries is limited owing to the overlying clavicle. Angiography is often indicated in order to precisely define the site of injury[30]. However, US examination of vertebral artery pseudoaneurysms is necessary in uncertain or difficult case from the beginning because it is convenient and sensitive in follow-up evaluation[116].

CONCLUSION

In conclusion, this review study showed that gray scale and Doppler ultrasound play an essential role in the diagnosis of pseudoaneurysms. The use of spectral Doppler in the diagnosis of pseudoaneurysms depends upon the presence of "to-and-fro" waveform. Incidence of arterial pseudoaneurysms are varied in the different body vasculature. Also the choice of pseudoaneurysms treatment is size dependent.

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CASE REPORT

Silver nitrate mimicking a foreign body in the pharyngeal mucosal space

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Abstract

Silver nitrate is sometimes used as a means of chemical cauterization for control of minor bleeding and management of hypergranulation tissue following bedside head and neck procedures. There are only few reports available on the imaging appearance of silver nitrate and its potential to mimic a foreign body. We report a case of a patient presenting with dysphagia, odynophagia, and fever following dental work who had a peritonsillar incision and drainage for treatment of a deep neck space infection. During the procedure, silver nitrate was applied to halt the bleeding. Patient was subsequently transferred to another institution. Since the patient was not showing significant clinical improvement on antibiotic therapy, a computed tomography (CT) scan was performed demonstrating a hyperdense structure lodged in the pharyngeal mucosal space in the oropharynx and soft palate that was mistaken for a foreign body such as bone. Silver nitrate can have density similar to bone but does not have the normal architecture of bone with cortex and marrow on CT. Familiarity with the appearance of silver nitrate on CT, lack of bone architecture, and proper documentation and communication of the use of silver nitrate to the consultant radiologist and medical personnel could help avoid misdiagnosis and potentially unnecessary surgical exploration.

Key words: Silver nitrate; Computed tomography; Bony foreign body; Soft tissues neck; Deep neck infections; Pharyngeal mucosal space

Core tip: This manuscript describes the imaging features of silver nitrate on computed tomography (CT). Silver nitrate is sometimes used as a means of chemical cauterization during bedside head and neck procedures. Silver nitrate has high attenuation on CT and has the potential to mimic a radio-opaque foreign body such as bone. However, it does not have the normal architecture of bone with cortex and marrow on CT. Familiarity with the appearance of silver nitrate on CT and proper communication of its use to the consultant radiologist could help avoid misinterpretation as a foreign body on imaging.

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INTRODUCTION

Silver nitrate is a form of chemical cautery commonly used for control of minor hemorrhage in the head and neck and in the management of hypergranulation tissue. Only few case reports describe the radiographic appearance of silver nitrate and its potential for imitation of a foreign body. We report a case of silver nitrate residue within the pharyngeal mucosal space in the oropharynx and soft palate imitating a foreign body on computed tomography (CT) imaging. Knowledge of the radiographic appearance of silver nitrate as well communication and documentation of its use can help prevent misdiagnosis as a foreign body and unnecessary surgical exploration.

CASE REPORT

A 52-year-old man presented to an outside emergency department with dysphagia, odynophagia, and fever following recent dental work. On examination, the patient was febrile with a temperature of 38.6 ℃ and swelling and tenderness of the anterior triangle of the neck on the left. A CT scan of the neck was performed, demonstrating phlegmon involving the pharyngeal mucosal space and parapharyngeal space including phlegmon in the peritonsillar region with only minimal areas of liquefaction (Figure 1). Complete blood count demonstrated an elevated white count with left shift. An outside consultant incised the peritonsillar space to rule out a peritonsillar abscess. Intravenous antibiotic therapy was initiated, and the patient was transferred to our service the following day.

Forty eight hours later, the patient showed no significant improvement and therefore a repeat CT scan of the neck was performed. The scan demonstrated a linear hyperdense structure with irregular margins along the pharyngeal mucosal space in the oropharynx and soft palate (Figure 2). The density of the structure was between approximately 380 and 580 Hounsfield units. The possibility of a foreign body, such as a chicken bone, was entertained based on the appearance, even though typical bone architecture with cortex and medulla was not identified. The patient's clinical history was, however, inconsistent with ingested foreign body impaction and its location was somewhat unusual. Furthermore, there was no sign of a foreign body on direct visualization. A thorough review of the management at the outside hospital was then performed, revealing that silver nitrate had been applied at the time of the peritonsillar incision for control of minor bleeding. A presumptive diagnosis of hyperdensity secondary to silver nitrate application was then made, supported by a literature review and identification of a few case reports describing that silver nitrate can be radiopaque on X-ray[1-3]. The patient's outside CT scan obtained prior to peritonsillar incision was then obtained and revised at our institution, revealing no evidence of a foreign body. This confirmed that silver nitrate was the source of the hyperdense structure. Conservative management with intravenous antibiotic therapy and observation was continued. The patient's symptoms resolved, and he was discharged 5 d following admission.

DISCUSSION

This report presents a case of a patient with a surgically explored pharyngeal mucosal space and peritonsillar region phlegmon who was not responding to treatment with the radiologic diagnosis confounded by silver nitrate application imitating a foreign body.

Infection of deep neck spaces can result in life threatening complications including airway compromise, sepsis, acute respiratory distress syndrome, jugular vein thrombosis, mediastinitis, disseminated intravascular coagulation, and death[4]. Foreign body trauma to the pharynx, dental infections, and oral surgical procedures are all known to initiate deep neck infections. CT scan is currently considered the gold standard imaging modality in the setting of a deep space neck infection. CT is widely available, can be obtained rapidly, and is helpful in identifying the etiology, establishing the extent of disease, and guiding the management of these patients.

Silver nitrate is an inorganic compound often used in emergency departments as topical chemical cautery due to its efficacy and ease of use. Silver nitrate is an oxidizing agent, producing free radicals and heat in aqueous solution, resulting in a necrosis and coagulation hemostasis[5]. Silver nitrate has also been used as an antiseptic for centuries, and has been shown to have antibacterial properties[6]. It is often used for coagulation of minor head and neck procedural bleeding. Importantly, silver nitrate is also radiopaque on X-ray[1-3].

There is a general lack of published literature regarding the radiographic appearance of silver nitrate, particularly on cross-sectional imaging and in the head and neck. To the best of our knowledge, there are 3 case reports describing the radiodense appearance of silver nitrate on plain radiographs of the extremities[1-3]. Madan *et al*[2] described a case of silver nitrate mimicking a foreign body on plain radiographs of the foot, where manual exploration was done and no foreign body found. Healy *et al*[1] reported two cases where silver nitrate was mistaken for a foreign body and/or dystrophic calcification on plain radiographs of the fingers[1]. Finally, Tong *et al*[3] reported a case of silver nitrate masquerading as an avulsion fracture or foreign body in the finger. The patient

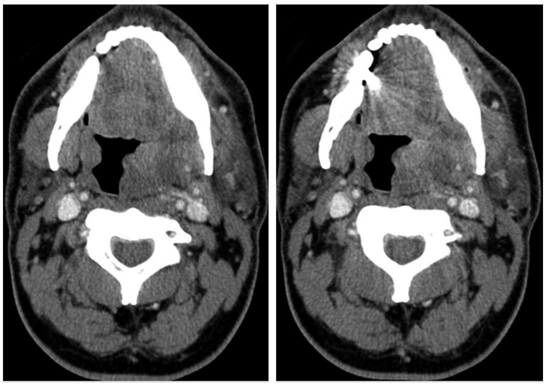

Figure 1 Axial computed tomography images at the level of the oropharynx prior to incision, drainage and silver nitrate application demonstrate swelling and enlargement of the left palatine tonsil and peritonsillar tissues with heterogeneous relatively low attenuation areas.

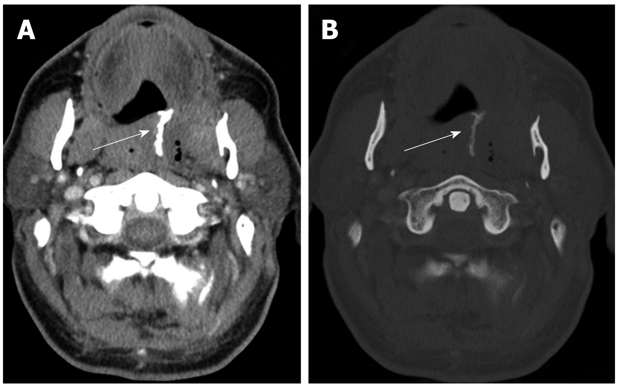

Figure 2 Axial computed tomography images from a scan performed 2 d after surgical exploration are shown, displayed in (A) soft tissue and (B) bone windows. The images demonstrate post-treatment changes with fluid and gas in the left palatine tonsil and peritonsillar region. In addition, there is a radiodense structure (arrow) in the pharyngeal mucosal space of the oropharynx and soft palate with density similar to bone, corresponding to the region of silver nitrate application. Note the absence of normal bone architecture such as cortex and medulla.

was managed conservatively and subsequent X-rays performed 2 wk later showed spontaneous resolution of the opacity. Our report appears to be the first case report describing the misleading appearance of silver nitrate both in terms of imaging modality (CT) and location in the soft tissues of the head and neck. In this case, we were able to avoid unnecessary pharyngeal exploration through careful analysis of the clinical context and CT images, supported by the limited medical literature on the topic.

This case highlights many important points. The use of silver nitrate in cauterizing soft tissue must be clearly documented and communicated to medical personnel, particularly in complex cases and those involving transfer of patient care to another institution. Furthermore, it is of special importance to communicate such history to the consultant radiologist. Although the lack of normal bone architecture in the hyperdensity reported raises the possibility of other etiologies as an imaging differential diagnosis, the provision of proper clinical information in such cases enables a much more confident diagnosis and helps avoid a misdiagnosis as a foreign body. This is of paramount importance in the context of pharyngeal mucosal space or parapharyngeal foreign bodies and deep space neck infections, where there is potential for unnecessary surgical exploration and associated morbidity for the patient. Given the widespread use of CT imaging in the evaluation and diagnosis of head and neck infections, it is important for radiologists and otolaryngologists to be familiar with the appearance of silver nitrate on CT and its potential to mimic radiodense foreign bodies and bone. Other imaging clues that may help avoid misdiagnosis include the absence of a typical bone structure such as cortex and medullary cavity.

COMMENTS

Case characteristics

Fifty five years old man transferred from another hospital post incision and drainage for a deep neck space infection who is not improving clinically on antibiotics.

Clinical diagnosis

Persistent swelling and pain in the neck without obvious abscess or foreign body on physical exam.

Differential diagnosis

Slowly resolving infection, infection resistant to antibiotic regimen, or infection complicated by abscess or other etiology such as foreign body.

Laboratory diagnosis

White blood cell count 16.1 × 10^9/L; 144 gm/L.

Imaging diagnosis

Computed tomography (CT) scan demonstrated a hyperdense linear structure along the pharyngeal mucosal space in the oropharynx and soft palate with density ranging between approximately 380 and 580 Hounsfield units that was initially interpreted as a potential foreign body such as bone. Re-review of the CT scan revealed no evidence of typical bone architecture, the patient's clinical history was inconsistent with ingested foreign body, and there was no sign of a foreign body on direct visualization. A thorough review of the management at the outside hospital was then performed, revealing that silver nitrate had been applied at the time of the peritonsillar incision. The CT scan at the time of initial presentation was also subsequently obtained and did not demonstrate any evidence of foreign body prior to incision and drainage and application of silver nitrate.

Treatment

Conservative management with intravenous antibiotic therapy was continued and the patient's symptoms resolved and patient discharged 5 d following admission.

Related reports

There are only few reports in the literature on silver nitrate mimicking foreign body on X-rays in the extremities. To the best of our knowledge, there are no descriptions of silver nitrate in the neck or on CT.

Term explanation

Silver nitrate is an inorganic compound often used in emergency departments as topical chemical cautery and also used for coagulation of bleeding associated with minor head and neck procedures.

Experiences and lessons

Awareness of the imaging appearance of silver nitrate and its use can prevent false diagnosis as a foreign body.

Peer-review

It is a well written case report.

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CASE REPORT

Diagnosis of prostatic neuroendocrine carcinoma: Two cases report and literature review

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Abstract

Two cases of prostatic neuroendocrine carcinoma (PNEC) imaged by computed tomography (CT) and magnetic resonance imaging (MRI), and literature review are presented. Early enhanced CT, MRI, especially diffusion-weighted image were emphasized, the complementary roles of ultrasound, CT, MRI, clinical and laboratory characteristic's features in achieving accurate diagnosis were valued in the preoperative diagnosis of PNEC.

Key words: Magnetic resonance imaging; Computed tomography; Neuroendocrine carcinoma; Diagnosis; Prostate

Core tip: Prostatic neuroendocrine carcinoma (PNEC) comprised 0.5%-2% of all prostate carcinoma, commonly presents with lymph node, bone, or organ metastases and has a poor prognosis when a definite diagnosis was given in clinic. Our cases and literature suggest it is usually insufficient that the prostate is examined by ultrasound and computed tomography (CT), or prostate specific antigen in serum for the symptomatic and/or with high risk factors crowd. Emphasizing the complementary roles of the malignant signs in diffusion-weighted image, early enhancement in CT or magnetic resonance imaging, self-contradictory clinical appearance and laboratory results can help achieving the accurate diagnosis of PNEC, maybe in early stage.

He HQ, Fan SF, Xu Q, Chen ZJ, Li Z. Diagnosis of prostatic neuroendocrine carcinoma: Two cases report and literature review. *World J Radiol* 2015; 7(5): 104-109 Available from: URL: http://www.wjgnet.com/1949-8470/full/v7/i5/104.htm DOI: http://dx.doi.org/10.4329/wjr.v7.i5.104

INTRODUCTION

According to the World Health Organization 2004 lung tumor classification, neuroendocrine carcinoma (NEC) was classified as carcinoid tumors, high-grade neuroendocrine carcinoma, small cell neuroendocrine carcinoma, and mixed tumors. Prostatic NEC (PNEC) comprised 0.5%-2% of all prostate carcinoma, commonly presents with lymph nodes, bone, or organ metastases and has a poor prognosis when a definite diagnosis was given in clinic[1-4]. Despite some clinical reports in the literature on the management of PNEC, there are limited articles describing its imaging features and diagnosis. To improve the preoperative diagnosis of PNEC, especially in its early stage, we review the related literature, and present two cases of PNEC with imaging, clinical, laboratory and pathologic findings, all showing metastasis at the time of diagnosis.

The study was approved by the Ethics Committee of Taizhou Hospital (Linhai, Zhejiang Province, China). Written informed consent was obtained from the patient's family.

CASE REPORT

Case 1

A 78-year-old male patient presented with pollakisuria and an episode of painless gross hematuria for about six-month duration. The patient had no family history of prostate cancer. Rectal examination outlined an irregularly enlarged prostate with an endured right lobe firmer than normal. In laboratory examination, prostate specific antigen (PSA) in serum at admission was within the normal range (0.2 ng/mL). In urine analysis, hemoglobin of 4.3 g/dL and red blood cells were found, while acid and alkaline phosphatase level was within normal range.

Ultrasonography showed an irregularly enlarged prostate size of 7.1 cm × 7.5 cm × 6.7 cm with inhomogeneous hypoechoic-isoechoic appearance. The diagnosis of ultrasonography was reported as prostatic hyperplasia. Computed tomography (CT) (Figure 1A and B) scans and magnetic resonance imaging (MRI) (Figure 1C and E) of pelvic revealed the prostate was approximately 6.5 cm × 7.5 cm × 7.2 cm in size with an irregular border and multiple enlarged lymph nodes in the pelvic region. CT images demonstrated the mass was slightly low density with small necrosis in the center region. The solid part enhanced obviously in contrast enhanced CT scanning, while the necrosis part did not. In MR examination, the solid part of the lesion appeared as slightly low signal on T1WI, while higher signal on T2WI and diffusion-weighted image (DWI), its ADC valve was 0.860 ± 0.130 mm^2/s. Abdominal CT, chest CT and/or lumbar MRI revealed several metastases in two lungs, liver, and multiple lumbar vertebraes (Figure 1F and H).

Based on the findings of laboratory examination, CT, MRI and literature review, a preferred diagnosis was offered that it was PNEC with pulmonary, hepatic, spine and lymph nodes metastasis.

To confirm the diagnosis in pathology, a biopsy of the enlarged prostate was performed. Microscopic finding showed infiltrating nests of small cell in the fibrotic stroma, the tumor cells of which had small hyperchromatic nuclei and scanty cytoplasms, Gleason 3 + 4 (Figure 2). In immunohistochemical staining, the lesion were positive for CgA and CD56, negative for PSA, which was consistent with small cell neuroendocrine carcinoma (Figure 3).

Systemic chemotherapy was offered to the patient but he refused it because of personal reasons. To palliate symptoms of the tumor and metastatic lesions, radiotherapy of 300 cGy/d for 10 d was carried out on the prostate, pelvic region and lumbar vertebrae. He died 7 mo after diagnosis.

Case 2

A 72-year-old male patient presented with one month of dysuria. Sonography showed the prostate enlarged to 4.0 cm × 5.1 cm × 4.2 cm with incomplete envelope, irregular shape and heterogeneous echo texture (Figure 4A). The serum level of PSA was within the normal range (0.73 ng/mL). CT scans of pelvic revealed the boundaries of increased prostate were unclear with bladder, seminal vesicle, and multiple enlarged lymph nodes in the retroperitoneal region (Figure 4B). In contrast enhanced CT scanning, obvious enhancement parts of enlarged prostate and lymph nodes were showed in arterial phase (Figure 4C and D). Chest and abdominal CT were obtained to check the other organs of the body, and found no evidence of lesions. CT signs suggested a diagnosis of prostatic malignant tumor accompanied by lymphatic metastasis. A preferred diagnosis of PNEC with lymph nodes metastasis was offered.

A biopsy of the prostate mass was adopted to confirm the diagnosis in pathology. Pathologic analysis of the fully sampled prostate and adjacent areas identified small cell carcinoma (Figure 5A, Gleason score 4 + 3 = 7), immunohistochemical studies (Figure 5B and D) showed positive staining with Syn(++), CgA(++), CD56(++), CK(+), AR(+++), and negative with CK20(-), PSA(-).

To remit and relieve symptoms of the tumor and metastatic lymph nodes, radiotherapy and systemic chemotherapy were carried out on the prostate and pelvic region. He survived for longer than the first case and died 29 mo after diagnosis.

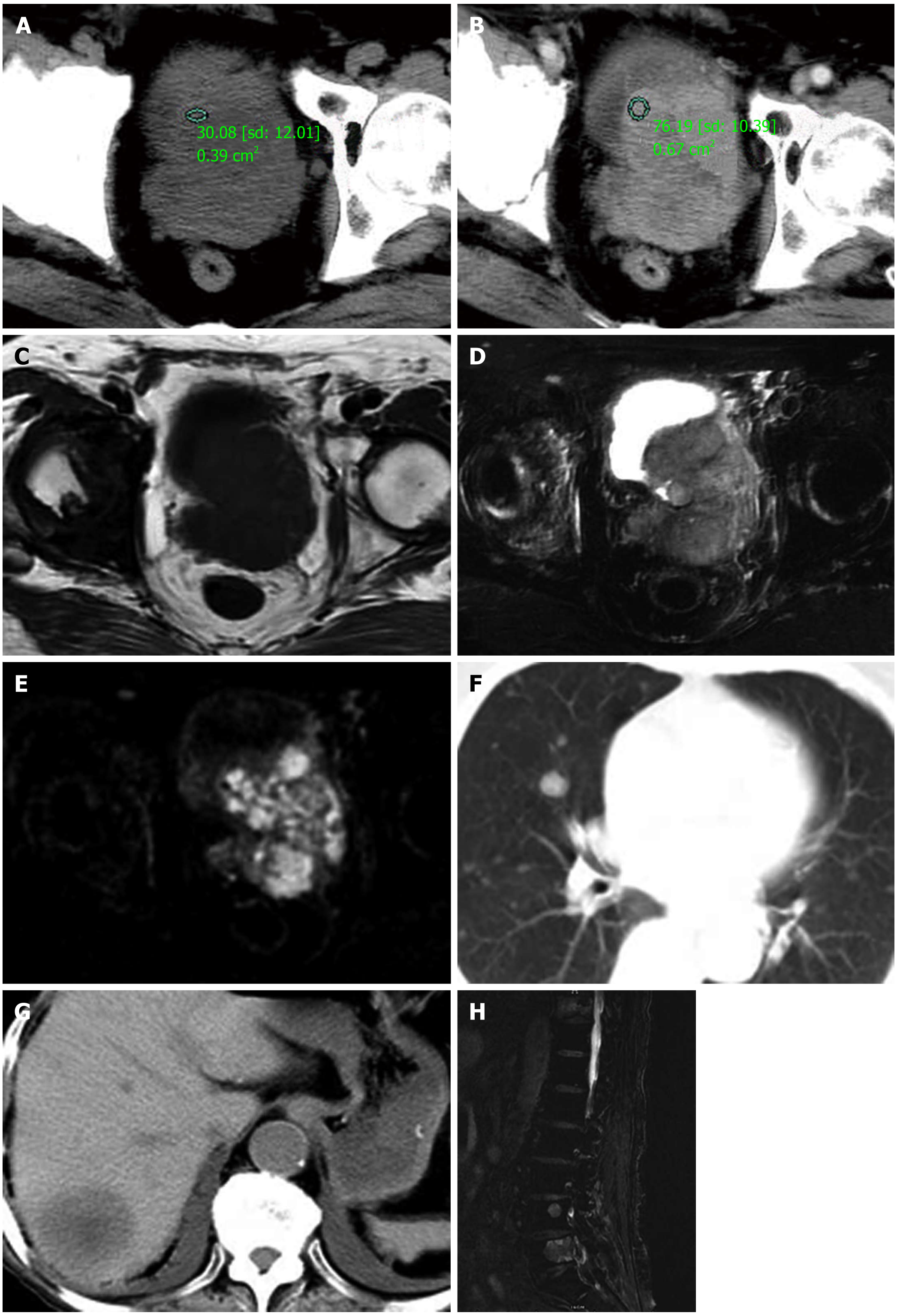

Figure 1 The diagnosis. Precontrast (A) and postcontrast (B) computed tomography (CT) images show the prostate approximately 6.5 cm × 7.5 cm × 7.2 cm in size with an irregular border and small necrosis in the center region, the solid part enhanced obviously in arterial phase of contrast enhancement CT scanning. T1-weighted image (T1WI, C) show the lesion to be slightly heterogeneous low signal intensity, T2WI (D), and diffusion-weighted image (E) show the same region to be heterogeneous hyperintense. Chest (F), abdominal (G) CT and lumbar (H) magnetic resonance imaging revealed multiple metastases to lungs, liver, and lumbar vertebraes.

DISCUSSION

PNEC, most identical to small cell carcinomas in clinic, is rare with different presentations and mostly diagnosed at the advanced stage by biopsy or surgery and generally believed to have a high metastatic potential and a poor prognosis[3-5]. Preoperative diagnosis, especially at the early stage of PNCE, may be helpful for surgery, adjuvant therapy and improving prognosis though it is difficult separately dependent on clinical, laboratory or imaging

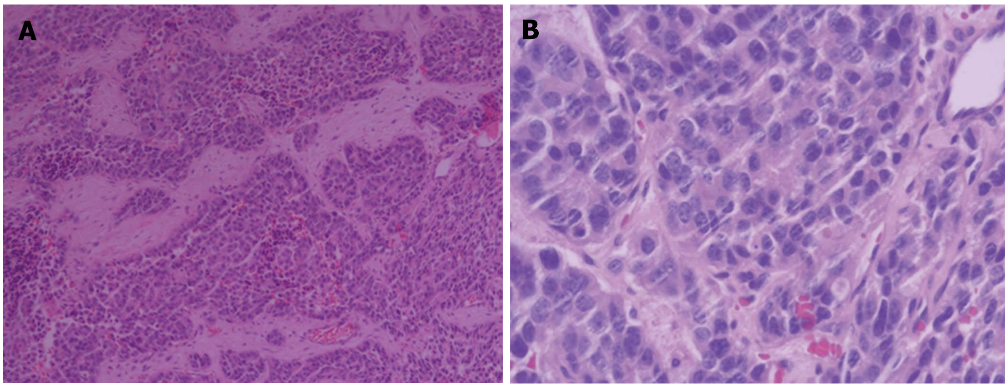

Figure 2 Microscopic finding showed infiltrating nests of small cells in fibrotic stroma. Tumor cells had small hyperchromatic nuclei and scanty cytoplasms. H and E: × 100 (A), and × 200 (B).

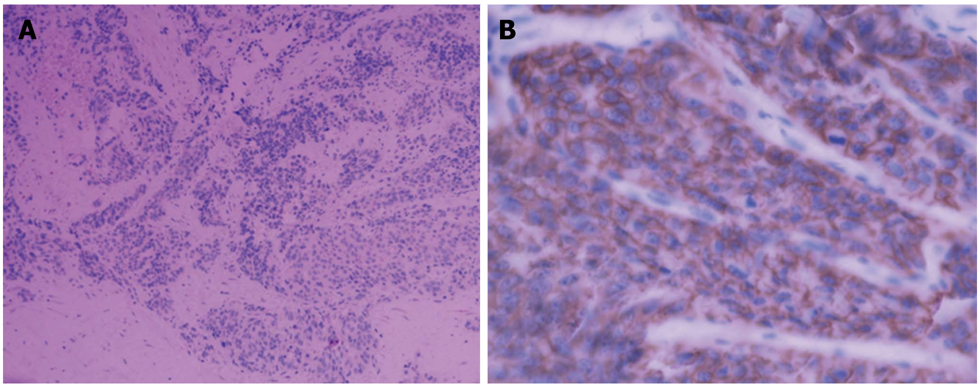

Figure 3 Immunohistochemical stain showed positivity of tumor cells for CgA (A) and a positive staining with CD56, CD56 (+) (B).

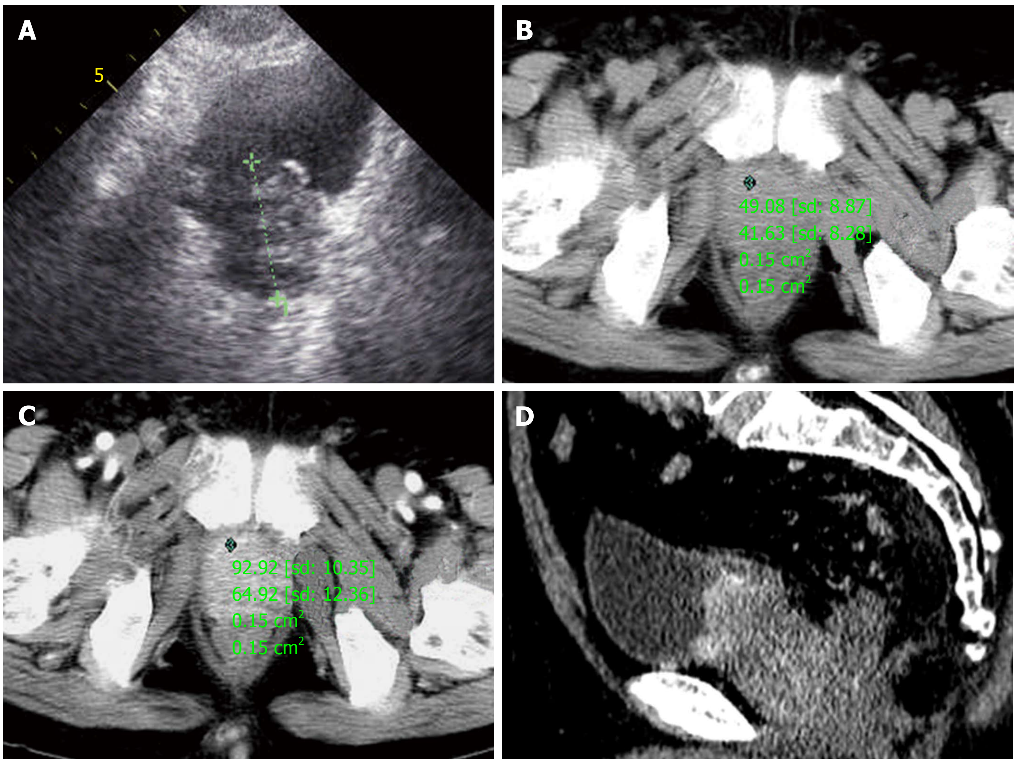

Figure 4 A 72-year-old male patient presented with one month of dysuria. A: Prostate enlarged to 4.0 cm × 5.1 cm × 4.2 cm with incomplete envelope, irregular shape and heterogeneous echo texture; B: A pre-enhanced computed tomography (CT) scan image of the pelvis showed a marked enlarged prostatic tumor invading to bladder, seminal vesicle; C: The enlarged prostate was inhomogeneous moderately enhancement in arterial phase; D: Coronal oblique multiplanar reconstruction of enhanced CT scan shows the enhanced inhomogeneous prostate with high attenuation protruding into bladder and unclear with surrounding tissue.

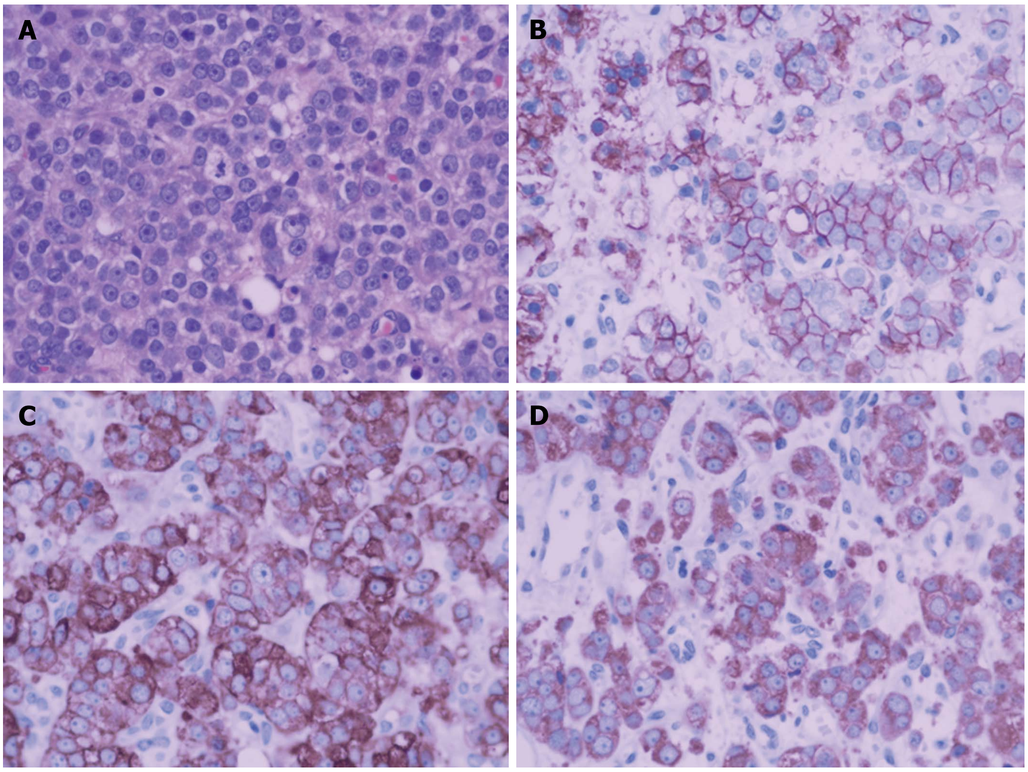

Figure 5 A biopsy of the prostate mass. Microscopic findings (A) showed infiltrating nests of small cells in fibrotic stroma. Tumor cells had small hyperchromatic nuclei and scanty cytoplasms (H and E, × 200). Immunohistochemical stain showed strong positivity of tumor cells for CD56(++) (B), CgA(++) (C), Syn(++) (D).

presentations.

The clinical features of this disease are similar to those of prostate adenocarcinoma. The most frequent symptoms at presentation include lower urinary tract symptoms and acute urinary retention, but pain and paraneoplastic syndromes may be the first manifestations in rare cases[2,4]. In our cases, the symptoms of the patients mainly include frequent urination, hematuria and dysuria, there were no paraneoplastic syndromes. Neuroendocrine cells of PNEC do not produce PSA, the serum level of PSA of the majority was within the normal range, except a few cases with mixed tumors with PSA slightly increased in serum[6,7]. In our cases, the serum level of PSA all were normal which is infrequent in prostate cancer.

The morphologic features of NEC of the prostate are similar to those of other sites. As for the prostate, the most widely used imaging examination is the pelvic ultrasonography, CT and MRI scan. To our knowledge, there are only several cases of PNEC which imaging signs have been primitively described in literatures by now[7,8], which are not sufficient to characterize the imaging findings of the tumor, but which hint MRI and contrast-enhanced CT examination may be sensitive in showing the abnormal signs. The radiologic findings of our cases were similar to the NEC in other sites. The imaging differences of PNEC to the benign diseases of prostate may include its higher signal in T2WI and DWI, more enhanced in arterial phase, irregular form infiltrated and/or metastasized to other regional, such as lymph nodes, bone or the liver and so on, which all can be seen in other malignant neoplasm of prostate though some signs are infrequency in others.

In summary, there usually isn't enough characteristic evidence for preoperative diagnosis, especially at early stage of PNCE alone in clinical, laboratory, plain ultrasound (US) or CT imaging presentations. If there are paraneoplastic syndromes though it is rare in clinic and malignant imaging signs, the diagnosis of PNCE can be made[8-10]. If there are malignant imaging signs, but without correspondingly increased PSA in serum and without paraneoplastic syndromes in clinic, PNCE should be considered in the differential diagnosis, which can be confirmed by biopsy, histology and immunohistochemistry[2,4,10]. Our cases and literature suggest PNEC often locate at the central zone of prostate with obviously contrast enhancement, abnormal signal in MR images, especially in DWI. It usually is insufficient that the prostate is examined by US and CT, or PSA in serum within normal range for the symptomatic and/or with high risk factors crowd. For patients with symptom and/or with high risk factors, DWI, early enhancement in CT, MRI should be emphasized, and the complementary roles of the imaging malignant signs, self-contradictory clinical appearance and laboratory results should be emphasized. Which can help achieving accurate diagnosis, maybe in early stage, in the preoperative diagnosis of PNEC. We believe it will test and enrich the imaging characteristics of PNEC to check more cases in future.

COMMENTS

Case characteristics

The clinical symptoms of the two cases were also dissimilar, one presented with pollakisuria and an episode of painless gross hematuria, and the other presented with dysuria.

Clinical diagnosis

Two men with prostatic malignant tumor.

Differential diagnosis

Malignant tumors (prostatic carcinoma, sarcoma, carcinoma sareomatodes and malignant fibrous histiocytoma), benign neoplasms (prostatic hyperplasia, granuloma).

Laboratory diagnosis

The first patient had hemoglobin of 4.3 g/dL and red blood cells in urine analysis, while the second patient had no remarkable findings for the laboratory tests.

Imaging diagnosis

For both cases, computed tomography (CT) scan and ultrasonography showed an irregularly enlarged prostate. The first case also underwent magnetic resonance examination.

Pathological diagnosis

For both cases, histological examination showed small cell carcinoma, immunohistochemical studies showed positive for CgA and CD56, negative for prostate specific antigen.

Treatment

The first case underwent only radiotherapy for 10 d on the prostate, pelvic region and lumbar vertebrae, while radiotherapy and systemic chemotherapy were all carried out on the prostate and pelvic region for the second patient.

Related reports

Very few ultrasound, CT and magnetic resonance imaging (MRI) findings of prostatic neuroendocrine carcinoma (PNEC) have been reported in the literature. The diagnostic value of imaging findings remains unclear and the role of treatment in early stage of PNEC is controversial.

Term explanation

PNCE: Prostatic neuroendocrine carcinoma.

Experiences and lessons

This case report presents the clinical and imaging characteristics of PNEC and also discusses the diagnostic value of imaging findings of PNEC. The authors recommend that more attention should be paid to the complementary roles of the malignant signs in diffusion-weighted image, early enhancement in CT or MRI, self-contradictory clinical appearance and laboratory findings.

Peer-review

Concise review of imaging and pathological findings of neuroendocrine prostate cancer.

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