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CASE REPORT

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^{123}I-MIBG uptake in the neck and shoulders of a neuroblastoma patient: damage to sympathetic innervation blocks uptake in brown adipose tissue

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Abstract Uptake of ^{123}I-MIBG in the neck and shoulders has recently been shown to be caused by uptake in brown adipose tissue. Unilateral absence of ^{123}I-MIBG uptake in brown adipose tissue ipsilateral to the clinical findings of a post-surgical Horner's syndrome suggests that, in humans, as in the animal model, uptake in brown adipose tissue is mediated by the sympathetic nervous system. This case further elucidates the mechanism of radiopharmaceutical uptake in brown adipose tissue and also suggests possible models for future studies of the physiology and pharmacology of brown adipose tissue.

Keywords Brown adipose tissue · Uptake · Metaiodobenzylguanidine

Introduction

^{123}I-Metaiodobenzylguanidine (MIBG) imaging has been extremely important in the staging and follow-up of patients with neuroblastoma [1]. In 1994, Paltiel et al. [1] and Bonnin et al. [2] reported ^{123}I-MIBG uptake in the neck and upper thoracic regions as a normal variant. Paltiel et al. [1] noted that the ^{123}I-MIBG uptake was in the neck and shoulders, in or near the trapezius muscle, while Bonnin et al. [2] wrote that the activity was in or adjacent to the pleura of the upper chest.

In 2002, Okuyama et al. [3] demonstrated ^{123}I-MIBG uptake in brown adipose tissue in rats. Cold stimulation is known to cause increased sympathetic outflow to brown adipose tissue [4]. In the same report, Okuyama et al. also showed that ^{123}I-MIBG uptake in the neck and shoulder regions in children was more common in cold weather than in warm weather [3].

A recent ^{123}I-MIBG imaging study in our laboratory in a child with surgical disruption of the sympathetic innervation in the neck and upper thorax demonstrated that ^{123}I-MIBG uptake in brown adipose tissue in the neck and shoulder is sympathetically mediated in children.

Case report

A 3-year-old girl with neuroblastoma was referred for ^{123}I-MIBG imaging. The patient's primary tumor was in her right upper chest in the paraspinal region. After resection of the tumor, two of the findings of a right Horner's syndrome were noted, ptosis and papillary miosis.

On images obtained 18 h after injection of 2.41 mCi (90 MBq) of ^{123}I-MIBG, there was no evidence of abnormal tumor uptake. There was uptake along the lateral edge of the left trapezius muscle, but there was no uptake on the right (Fig. 1). Slight uptake adjacent to the lateral pleura was present bilaterally on coronal images (Fig. 2).

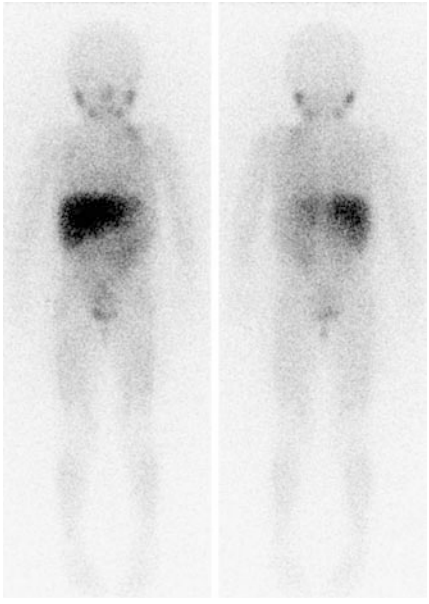

Fig. 1a, b Anterior (**a**) and posterior (**b**) whole-body images demonstrate absence of ^{123}I-MIBG in brown adipose tissue in the right side of the neck and shoulder and normal uptake on the left. The patient developed a Horner's syndrome on the right side after resection of an upper thoracic neuroblastoma on the right

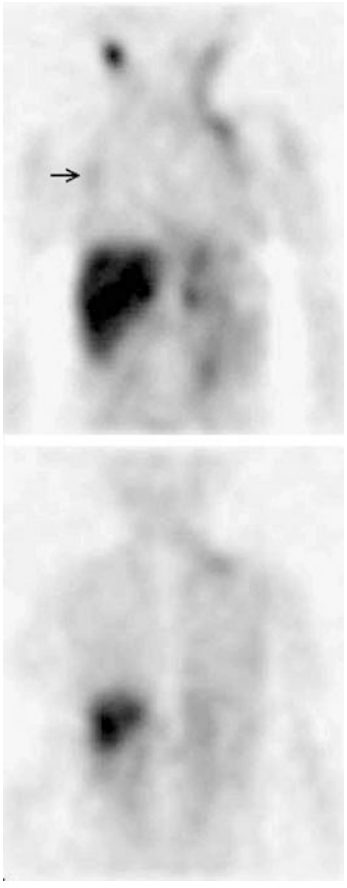

Fig. 2a, b Two single photon emission tomography (SPECT) coronal sections again demonstrate absent uptake in most of neck and posterior thorax. A small amount of uptake is noted in the right lateral chest (*arrow*) corresponding to brown adipose tissue uptake present more extensively on the left

Discussion

^{123}I-MIBG studies and recent [^{18}F] 2-fluoro-2-deoxy-glucose positron emission tomography (FDG PET) studies have demonstrated a much wider anatomic distribution of brown adipose tissue than was known. Uptake may be seen in the neck, supraclavicular regions, along the lateral margins of the trapezius muscles, draping the apices of the lungs (sometimes extending to the level of the mid-chest along the lateral parietal pleura), and adjacent to multiple costovertebral joints (often extending to the diaphragm) [1, 2, 3, 5, 6].

In our patient, surgical interruption of right upper thoracic and cervical sympathetic innervation, as manifested by the patient's right Horner's syndrome, blocked ^{123}I-MIBG uptake in brown adipose tissue in right neck and shoulder regions. However, a small amount of ^{123}I-MIBG uptake in brown adipose tissue was seen bilaterally below the level of interruption of innervation on the right. ^{123}I-MIBG uptake was also noted in the right submandibular and parotid glands. In the case report of Sandler et al. [7], postsurgical injury to the sympathetic chain eliminated parotid gland uptake on the ipsilateral side. In this patient, brown adipose tissue uptake and the sympathetic fiber of the third cranial nerve were affected.

Sympathetically mediated ^{123}I-MIBG uptake in brown adipose seldom causes a problem in the interpretation of MIBG scans. On such scans, this uptake is infrequently seen in patients older than 7 years [1]. In patients with neuroblastoma, nodal uptake is easily distinguished from uptake in brown adipose tissue, and there is no need for pharmacological suppression of this uptake [8]. However, this new understanding of ^{123}I-MIBG uptake in brown adipose tissue may help us approach what is proving to be a more important problem, FDG uptake in brown adipose tissue on PET images.

FDG uptake in brown adipose tissue is often in the same locations as lymph nodes that may be involved with lymphoma or other tumors in the neck and chest [6]. FDG uptake in brown adipose tissue may hide tumor uptake of FDG or may be indistinguishable from tumor uptake. With FDG, these uptake patterns may occur not only in the entire pediatric age group (including teenagers), but also in young and middleage adults [6, 8]. FDG uptake is stimulated by a cold environment, most likely through the same pathways as ^{123}I-MIBG uptake [9]. Warming patients before FDG

injection and pharmacologic suppression of cold-mediated uptake in brown adipose tissue have been only partially effective in eliminating this problem [8].

Both ^{123}I-MIBG and labeled 2-deoxyglucose (as FDG in humans and labeled with ^{14}C in small animals) can be used in future investigations of the physiology and pharmacology of brown adipose tissue. Studies of the pharmacology of brown adipose tissue may help eliminate clinical problems with brown adipose tissue uptake in PET imaging.

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