Role of Magnetic Resonance Imaging in evaluation of thymic gland tumors

Essay
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«رَبَّنَا عَلَيْكَ تَوَكَّلْنَا وَإِلَيْكَ أَنَبْنَا وَإِلَيْكَ الْمَصِيرُ»

(الممتحنة: من الآية4)

Dedication

To my parents,

For your never ending support

To my friend Sarah Ibrahim, & my sister Noha

for their love and support.

Sarah el Sanhoury

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First and foremost, thanks to Allah

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Introduction

More than 90% of all thymic tumors occur in the anterior mediastinum while the remainders are located at the neck or other mediastinal areas **(Srirajaskanthan R. et al, 2008)** Epithelial tumors (thymoma and thymic carcinoma) are the most common primary neoplasms of the thymic gland and of the anterior mediastinum as well**. (Inoue A. et al, 2006**)

Thymomas generally occur in patients older than 30 years. About 70% of these lesions are found in adults in the fifth & sixth decades. Thymic carcinoma occurs in the range of 10-76 years old, with peak age 47-60 years. Thymic lymphoma has a bimodal pattern distribution, with the first peak at 16 years and the second peak after the age of 40 years. Thymolipoma and Teratoma occur most frequently in children and young adults. (**Srirajaskanthan R. et al, 2008**).

Currently; the thymus gland is assessed by chest radiography and computed tomography (CT) that refines lesion localization and allows for evaluation of the morphologic features of thymic masses. However, there are many overlapping features that usually make them difficult to be diagnosed correctly. **(Sadohara J. et al, 2006)**

MRI, owing to its good tissue characterization, is superior to CT for visualizing the thymus gland and for differentiating the thymic tissue from the surrounding structures. Further more, MRI provides excellent mediastinal cross-sectional images without need for contrast enhancement; particularly in patients

who cannot tolerate intravenous contrast material. (**Srirajaskanthan R. et al, 2008**). Encasement or invasion of the nearby vasculature, esophagus & trachea and involvement of the pericardium, myocardium, and pleura could be accurately detected with MRI. MR is superior to CT for depiction of the tumor capsule, intra-tumoral septae, and intrinsic lesion hemorrhage**. (Rosado-de-christensen M. et al, 2008**)

Familiarity with the classification schemes for thmyic epithelial tumors, especially the current WHO (World Health Organization) classification scheme, and awareness of the correlation between these classification schemes and radiological findings are necessary if the radiologist is to contribute to the clinical treatment of affected patients (**Nishino M. et al, 2006**)

The WHO pathological classification has been realistically shown to be correlated with the prognosis and the clinical features of thymic epithelial tumors. Recent studies aimed to correlate the MR imaging features of the various subtypes of thymic epithelial tumors to their histo-pathological types based on the WHO classification with the aim of improving tumor management **(Inuoe A. et al, 2006)**.

Radiologists must be able to distinguish thymic hyperplasia from neoplasm. However, differentiation may be difficult on the basis of morphologic features alone**. (Mendelson DS; 2001).**

It has recently been reported that chemical shift MR imaging is useful for differentiating between thymic hyperplasia and thymic gland tumors. It is reasonable to assume that chemical shift MR imaging will reveal no decrease in the signal intensity of tumors

of the thymus gland because these organs usually do not include fat **(Inaoka T. et al, 2007).**

Dynamic MR imaging is useful in the evaluation of the anterior mediastinal tumors,as differentiates between thymoma and thymic carcinoma,as well as it is helpful in staging of thymoma .

Aim of the work

The aim of this study is to determine the role of magnetic resonance imaging ,chemical shift MR imaging, and dynamic MR imaging in the evaluation of thymic tumors with special focus on thymic epithelial tumors in correlation with WHO classification.

EMBRYOLOGIC FEATURES OF THE THYMUS

The thymus develops as a bilateral structure from the third pharyngeal pouch of the embryo in common with the inferior parathyroid glands **(Shimosato Y, Mukai K.1997)**. Subsequently it descends with the pericardium from the neck into the thorax. Thus it may retain a fibrous connexion with one or both of the inferior parathyroid glands in the neck **(G.J. Romanes.1997)**. Development of the thymus begins in the 6th gestational week. Migration of tissue occurs during the 8th week, leading to a fusion of the bilateral lobes, with the thymus occupying its final position in the antero-superior mediastinum. In the course of its development, until the 9th gestational week, the thymus remains purely epithelial. By the 10^{th} week, small lymphoid cells migrate from fetal liver and bone marrow, leading to lobulation of the gland. Further differentiation into cortex and medulla is completed by 14- 16 weeks **(Suster S,Rosai J.1990)** .Thereafter, the thymus grows rapidly and attains its greatest weight in relation to body weight before birth (average, 15 g)**(Nagasawa K,et al.2004).**Because the thymus migrates from the third branchial pouch to the anterior mediastinum during its course of development, ectopic thymic tissue or ectopic thymoma can occur anywhere along this pathway **(Kakuno Y, et al.2002)**.

Anatomy :

The appearance of the thymus varies considerably with age. It is largest in the early part of life up to the age of 15 years. It is a soft, bilobed organ, and its two parts lie close together side by side, joined in the midline by connective tissue that merges with the capsule of each lobe **(Moran CA,Klemm KM.1999).**

Position and relations

The greater part of the thymus lies in the superior and anterior mediastinum, and the lower border of the thymus reaches the level of the fourth costal cartilages. Superiorly, extensions into the neck are common, reflecting the bilateral embryonic origins of the thymus from the third pharyngeal pouch. It sometimes reaches the inferior poles of the thyroid gland or even higher **(Rosado-de-Chritenson,et al.2008**). Its shape is largely moulded by the adjacent structures. Inferiorly, the lower end of the right lobe is commonly between the right side of the ascending aorta and the right lung, anterior to the superior cava. Anterior to the gland in the neck are sternomastoid and sternothyroid muscles and fascia; in the thorax the gland is covered anteriorly by the manubrium, the internal thoracic vessels, the upper three costal cartilages, and laterally by the pleura.Posteriorly, it is in contact with the vessels of the superior mediastinum, especially the left brachiocephalic vein, which may be partly embedded in the gland, and with the upper part of the thoracic trachea and the upper part of anterior surface of the heart.

Ectopic thymic tissue is sometimes found. Small accessory nodules may occur in the neck. They represent portions that

have become detached during their early descent. The thymus may be found even more superiorly as thin strands along this path reaching the thyroid cartilage or above. Connective tissue marking the line of descent during early development may occasionally run between the thymus and the parathyroids **(Standring S,et al.2005).**

Vascular Supply And Lymphatic Drainage

Arteries

The thymus is supplied mainly from branches of the internal thoracic and inferior thyroid arteries, which also supply surrounding mediastinal connective tissue. A branch from the superior thyroid artery is sometimes present. There is no main hilum, but arterial branches pass either directly through the capsule or, more often, into the depths of the interlobar septa before entering the thymus at the junction of the cortex and medulla.

Veins

Thymic veins drain to the left brachiocephalic, internal thoracic and inferior thyroid veins. One or more veins often emerge medially from each lobe of the thymus to form a common trunk opening into the left brachiocephalic vein.

Lymphatic drainage

The thymus has no afferent lymphatics. Efferent lymphatics arise from the medulla and corticomedullary junction and drain through the extravascular spaces in company with the arteries and veins entering and leaving the thymus. Thymic lymphatic vessels end in the brachiocephalic, tracheobronchial and para-sternal nodes **(Standring S,et al.2005).**

Innervation

The thymus is innervated from the sympathetic chain via the cervico-thoracic (stellate) ganglion or from the ansa subclavia and from the vagus. Branches from the phrenic nerve and descending cervical nerve are distributed mainly to the capsule of the thymus. During development, the thymus is innervated by the vagus in the neck before its descent into the thorax. The two lobes are innervated separately through their dorsal, lateral and medial aspects, and rich neural plexuses are formed in the medulla. After its descent, the thymus receives the sympathetic nerves along vascular routes: their terminals branch radially and form a plexus with the vagal fibres at the corticomedullary junction. Innervation is complete by the onset of thymic function. Many of the autonomic nerves are doubtless vasomotor, but many terminal branches also (at least in rodents) leave their perivascular pathways and pass among the cells of the thymus, particularly the medulla, suggesting that they may have other roles. The medulla contains a variety of non-lymphoid cells, including cells positive for vasoactive intestinal polypeptide and acetylcholinesterase, large non-myoid cells and cells containing

oxytocin, vasopressin and neurophysin, of possible neural crest origin. The roles of the nervous system and other neuroendocrine elements in the overall biology of the thymus are little understood **(Standring S,et al.2005).**

Function

Each lobule contains an outer cortex and an inner medulla. These distinct zones support different stages of T-lymphocyte development. The cortex contains immature T-lymphocytes, special epithelial cells called nurse cells, and some macrophages. The medulla contains epithelial cells and T-lymphocytes that have completed maturation. In addition, the medulla contains thymic corpuscles (Hassall corpuscles), which are circular aggregations of aged, degenerated nurse cells **(Nishino M,et al.2006).**

The thymus functions as a site for T-lymphocytes maturation and differentiation. Immature lymphocytes migrate to the thymus during embryonic development. These immature cells then reside in the cortex of each lobule. The nurse cells in the cortex secrete several thymic hormones that stimulate T-lymphocyte maturation and differentiation. T-lymphocytes within the thymus do not participate in the immune response and are protected from antigens in the body by a well formed blood thymus barrier around the blood vessels in the cortex. When the T-lymphocytes differentiate (e.g.,mature into helper T-lymphocytes or cytotoxic T-lymphocytes), they migrate to the medulla of each lobule. No blood thymus barrier is present in the medulla, so the mature T-lymphocytes enter the blood stream and migrate to other