Hemodynamic Changes of Pheochromocytoma Patients during Laparoscopic Adrenalectomy

Essay

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By

Ahmed Adel Mohammed

MB.B.Ch.

Faculty of Medicine – Ain Shams University

Under Supervision of

Prof. Dr. Samir Abdel Rahman El Sebiae Talkhan

Professor of Anesthesiology and Intensive Care

Faculty of Medicine - Ain Shams University

Prof. Dr. Mohamed Sidky Mahmoud

Professor of Anesthesiology and Intensive Care

Faculty of Medicine - Ain Shams University

Assist. Prof. Dr. Dalia Mahmoud Elfawy

Assistant Professor of Anesthesiology and Intensive Care

Faculty of Medicine - Ain Shams University

Faculty of Medicine

Ain Shams University

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Ahmed Adel Mohammed

List of Contents

List of Abbreviations

Abbr.	Full-term
ACTH	**:** Adrenocorticotropic hormone
BMI	**:** Body mass index
CT	**:** Computed tomography
ECG	**:** Electrocardiography
ED	**:** Electrochemical detection
FDA	**:** Fluorodopamine
F-DOPA	**:** 18-fluoro-dihydroxy-phenylalanine
F-FDG	**:** 18-fluorodeoxy-glucose
HVA	**:** Homovanillic acid
ISP	**:** International Symposium on Pheochromocytoma
LA	**:** Laparoscopic adrenalectomy
LC	**:** Liquid chromatography
MAO-A	**:** Monoamine oxidase A
MAP	**:** Main arterial pressure
MIBG	**:** Meta-iodo-benzyl- guanidine
MRI	**:** Magnetic resonance imaging
MSCT	**:** Multislice Spiral Computed Tomography
PACU	**:** Post-anesthesia care unit (PACU)
PET	**:** Positron emission tomography

PHEO **:** Pheochromocytoma

PRA **:** Posterior retroperitoneoscopic adrenalectomy

VM **:** Vanillylmandelic acid

VMAT **:** Vesicular monoamine transporter

List of Figures

Abstract

Background: Pheochromocytoma is a catecholamine secreting tumour that arises from the chromaffin cells of the sympathetic nervous system in the adrenal medulla and the sympathetic chain; however, it may arise anywhere in the body. Patients present with a variety of symptoms which reflect excessive secretion of catecholamines (norepinephrine, epinephrine, or dopamine) into the circulation. The released catecholamines cause significant hypertension, often severe and refractory to conventional treatment. Aim of the work: The aim of this essay is to review hemodynamic changes of pheochromocytoma patients during laparoscopic adrenalectomy. **Conclusion:** a need for patients to avoid medications which affect assays or which interfere with catecholamine metabolism. Most common drugs causing false positive results are tricyclic antidepressants and antihypertensive medications.

Key words: hemodynamic changes, pheochromocytoma, laparoscopic adrenalectomy

Introduction

Adrenal glands are situated in the extraperitoneal perirenal space. There are great varieties of the adrenal diseases and their clinical manifestations are complicated. Therefore, adrenal glands are one of the interesting investigative subjects of the clinic, especially in medical imaging and surgery. The development of Multislice Spiral Computed Tomography (MSCT) and its image postprocessing ability as well as modern high-speed scanning sequence of MRI provide useful images that more clearly demonstrate the complicated anatomical relationships of the adrenal glands and their diseases on the transverse, sagittal, coronal, and oblique planes ***(Blake et al., 2006).***

Pheochromocytoma is a rare catecholamine secreting tumor arising from chromaffin cells in adrenal medulla or other paraganglia in the body, which may be associated with many genetic syndromes and mutation. The role of endocrinologist is in biochemical diagnosis of suspected cases; its anatomic and functional localization with the help of imaging like CT, MRI, and nuclear scanning; preoperative control of hypertension; and postoperative follow up of cases that have undergone surgical resection. Familial and genetic screening of cases and their family is important to detect occult cases. Endocrinologist will also play a role in cases with malignant pheochromocytoma in assessment of metastasis, control, chemoradiotherapy, and follow up ***(Garg et al., 2011).***

Pheochromocytoma has got multidimensional challenging aspects in spite of improved understanding of its physiological and clinical behavior during surgical resection. The most common manifestations of this clinical spectrum include hypertension, headache, palpitations and episodic sweating. The definite and only treatment for this rare tumor is surgical resection which itself is very challenging for an anesthesiologist ***(Mackenzie et al., 2007).***

Laparoscopic technique is preferred for many types of surgical procedures. Advantages of laparoscopic surgery include small incisions, postoperative pain reduction, decreased analgesic consumption, small scar formation, decreased incidence of postoperative pulmonary morbidity and ileus, rapid recovery, shorter hospital stay, higher patient satisfaction, and cost-effectiveness ***(Joris, 2010).***

The anesthetic management of these laparoscopic adrenalectomies can be very challenging. In addition to commonly observed changes in heart rate and blood pressure during insufflation and desufflation applied in laparoscopic surgery, the adrenal gland hormones are secreted by manipulation of the adrenal gland during surgical removal and might cause severe changes on hemodynamics ***(Nizamog et al., 2011).***

Aim of the Work

The aim of this essay is to review hemodynamic changes of pheochromocytoma patients during laparoscopic adrenalectomy.

Chapter (1):
Anatomy of Adrenal Gland

The adrenal gland is composed of two separate functional units, the cortex and the medulla. Although these units have completely separate origins, they unite within a single capsule during fetal life ***(Mitty, 1988).***

The Cortex

The cortical primordium of the adrenal gland arises from developing peritoneal epithelium or coelomic mesoderm. These mesenchymal cells are located on the posterior trunk at the angle of the genital ridge and the root of the mesentery. This group of cells grows rapidly and penetrates the retroperitoneal mesenchyme near the cranial end of the mesonephros to form the primitive cortex by the fifth week of embryologic development. This primitive cortex (provisional cortex, fetal zone, transitional zone, X-zone) accounts for the bulk of the cortex during fetal life. At 7 weeks (12 mm embryo), a second wave of cells migrate from the cortical primordium to envelope the primitive cortex and form a permanent cortex. At the end of the 8th week, the cortical mass separates from the peritoneal mesothelium and becomes encapsulated by connective tissue. The gland is now much larger than the kidney ***(Williams and Warwick, 1980).***

The Medulla

Ectodermal cells from the neural crest migrate forward to become the primitive sympathetic ganglia. Some of these cells do not differentiate into neurons but instead become endocrine cells. They are call chromaffin cells or pheochromoblasts because they stain brown when exposed to chromic acid salts. This reaction is due to the presence of epinephrine and norepinephrine in the cells. These cells are widely dispersed in the embryo. At about the 10^{th} week of development, a group of chromaffin cells from the primitive sympathetic ganglia migrate and invade the medial aspect of the fetal adrenal cortex. By the 18^{th} week, these cells have achieved their position central to the cortex ***(Williams and Warwick, 1980).***

During fetal development, most medullary functions originate from the larger paraganglionic masses. Significant adrenal medullary function is not evident until about the 11^{th} week of development. After birth, much of eth paraganglionic tissue atrophies and the adrenal medulla predominate. Some of the paraganglionic chromaffin tissue may remain as discrete structures near the origin of the celiac and of the superior mesenteric artery. Accessory medullary tissue may also be found with sympathetic nerves as well as near the

origin of the inferior mesenteric artery, where it is called the organ of Zuchkerkandl ***(Dupin and Sommer, 2008).***

It is interest that during gestation and at birth the catecholamine content of the medulla and paraganglionic tissue is almost all norepinephrine. By 2 years of age this changes, so that 80% of the medullary output is epinephrine ***(West et al., 1951).***

Anatomy

The adrenal gland may be described as having superior, middle, and basal portions, or tail, body, and head. The head is the most inferior portion and contains most of the medulla, with a corticomedullary ratio of 4:1. The body has a small amount of medulla, resulting in a corticomedullary ratio of 15:1. The tail is essentially all cortex. Microscopic remnants may also be found in the course of the sympathetic chain ***(Mitty, 1988).***

Anatomic Relationships

The adrenal glands are located at the level of the 11^{th} or 12^{th} rib lateral to the vertebrae in the extreme supero-posterior portion of the retroperitoneal perirenal space ***(Mitty and Yeh, 1982).*** The left gland extends as low as L-l, often joining the anterior portion of the renal vascular pedicle where the adrenal

vein drains into the renal vein. The glands are attached to the inner surface of the anteromedial and superior aspects of the perirenal fascia. Like the kidney, the glands are surrounded by fatty areolar tissue, which is useful in separating them from adjacent structures such as the liver, kidneys and aorta (Fig 1). On the right, this areolar tissue thins and practically disappears between the gland and the posterior aspect of the inferior vena cava. It is important to recognize that the kidney is not fixed to the perirenal fascia. For this reason, deep inspiration or the upright position often causes separation of the adrenal and kidney. This separation maneuver, particularly during sonography, can be employed to help demonstrate whether a mass is of renal or adrenal origin ***(Mitty and Yeh, 1982).***