شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

بسم الله الرحمن الرحيم

HANAA ALY

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

HANAA ALY

شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار

HANAA ALY

A Study of the Effect of Cutaneous Electric Stimulation on the Structure of The Anal Sphincter of Rat After Induction of Anal Muscle Injury

Thesis
Submitted in partial fulfillment of the
MD degree in anatomy and embryology

Presented by

Diana Eid Aziz
Assistant lecturer
Faculty of Medicine- Ain Shams University

Under supervision of

Prof. Dr. Nawal Fouad Rizkalla.
Professor of Anatomy and Embryology
Faculty of Medicine - Ain Shams University.

Prof. Dr. Eman Kamal Mohamed Habib.
Professor of Anatomy and Embryology
Faculty of Medicine - Ain Shams University

Dr. Mervat Thabet Naguib.
Assistant Professor of Anatomy and Embryology
Faculty of Medicine - Ain Shams University.

Dr. Enas Anwar.
Lecturer of Anatomy and Embryology
Faculty of Medicine - Ain Shams University

2020

Acknowledgement

First, thanks are all due to Allah for Blessing this work until it has reached its end, as a part of his generous help throughout our life.

My profound thanks and deep appreciation to ***Prof. Dr. Nawal Fouad Rizkalla***, professor of Anatomy and Embryology Department, Faculty of Medicine - Ain Shams University, for her great support and advice, her valuable remarks that gave me the confidence and encouragement to fulfill this work.

I am also thankful to ***Prof. Dr. Eman Kamal Mohamed Habib***, Assistant professor of Anatomy and Embryology, Faculty of Medicine - Ain Shams University, for her valuable supervision, co-operation and direction that extended throughout this work.

I am deeply grateful to ***Dr. Mervat Thabet***, Professor of Anatomy and Embryology, Faculty of Medicine - Ain Shams University for adding a lot to this work by her experience and for her keen supervision.

I would like to direct my special thanks to lecturer ***Dr. Enas Anwar***, Assistant professor of Anatomy and Embryology, Faculty of Medicine - Ain Shams University, for her valuable help, fruitful advice, continuous support offered to me and guidance step by step till this thesis finished.

My deep thanks and deep appreciation to ***Prof. Dr. Shahera Youssef***, head of the Anatomy and Embryology Department, Faculty of Medicine – Ain Shams University, for her great help, support and her valuable advices and encouragement to finish this work.

I cannot forget the great help of ***Dr. Maha Moustafa Ahmed Zakaria***, and ***Dr. Ahmed Farid*** Lecturers of Anatomy and Embryology, Faculty of Medicine - Ain Shams University, for their valuable help.

I am extremely sincere to my family who stood beside me throughout this work giving me their support.

Words fail to express my love, respect and appreciation to my husband for his unlimited help and support.

List of Contents

Introduction

It has been known that the muscles of the anus perform a critical role in maintaining continence. Any defect in their structure can negatively affect the physiological control of feces.

Fecal incontinence is one of the most psychologically and socially devastating conditions in a healthy individual. It can lead to social isolation and loss of self-confidence ***(Rao, 2004).*** True anal incontinence is the loss of the anal sphincter control leading to unwanted passage of feces or gas. This must be distinguished from other conditions that can lead to stool passing through anus such as hemorrhoids, enlarged skin tags and rectal mucosal prolapse ***(Ternent et al., 2015).***

Vaginal delivery is accepted as the most common predisposing factor to fecal incontinence in young and healthy women ***(Pretlove et al., 2008)***. Rate of fecal incontinence in women is as many as 13-25% after vaginal delivery ***(Guise et al., 2007).*** Vaginal delivery may result in internal or external anal sphincter disruption, or may cause damage to the pudendal nerve. In addition, inadequate repair of obstetric sphincter injuries may lead to delayed symptoms of fecal incontinence ***(Shin et al., 2015)***.

Sultan et al., (1994) found that approximately half the women (47%) who sustained a third-degree tear experienced some impairment of anal continence despite a primary repair.

Therapeutic approaches dealing with the treatment of fecal incontinence depend on its degree and severity. The most recent one is the anorectal electro-stimulation, which has been shown in different

studies to improve local sensitivity, control of the defecation reflex and increase in the anal closure pressure ***(de Sousa et al., 2017).***

Aim of the work

The present work aimed to investigate the effect of cutaneous electrical stimulation upon regeneration of the anal sphincter in a rat model subjected to injury. That anal sphincter injury was applied in a way to resemble the injury in external and internal anal muscles that could result from a normal vaginal delivery in human.

Review of the literature

The anal canal is an important body part. Some terms are used to describe the anal canal, such as the anatomic, surgical, or histological anal canal ***(Noah and Samuel, 2011).***

Anatomy of the anal canal

The anal canal is the most terminal part of the gastrointestinal tract, which lies between the anal orifice in the perineum below and the rectum above**.** It is placed within the anal triangle of the perineum between the right and left ischioanal fossae ***(Noah and Samuel, 2011)***. At the junction of the rectum and the anal canal, there is a muscular ring known as the **anorectal ring**. It is formed by the fusion of the internal anal sphincter, external anal sphincter and puborectalis muscle, and is palpable on digital rectal examination ***(Luis, 2018).***

There are no teniae coli at the level of the rectum; the longitudinal layer of the muscularis externa forms a uniform sheet. The muscularis mucosa disappears at about the level of the anal transitional zone (ATZ), where the circular layer of the muscularis externa thickens to form the internal anal sphincter. The external anal sphincter is formed by striated muscle of the pelvic floor ***(Standring, 2015)***.

Functionally, the anal canal represents a zone of high pressure. It is between 2 and 5 cm long in adults; the anterior wall is slightly shorter than the posterior. It extends from the upper aspect of the pelvic diaphragm to the anus. Frequently it is longer in men than in women, while elderly subjects or patients with incontinence frequently show a to some extent shorter canal than healthy young volunteers. At rest, it forms

an oval or triradiate slit in the anteroposterior plane rather than a truly circular canal ***(Enck et al., 2005)***.

Histology of the anal canal

The anal canal consists of an inner epithelial lining (mucosa), submucosa, an internal and an external anal sphincters, and fibromuscular supporting tissue, as well as dense neuronal networks of autonomic and somatic origin ***(Kinugasa and Moriya, 2012)***.

Enck et al., (2005) described section through the anal canal that shows the following layers: the mucosa (about 0.5–1 mm), the circularly arranged smooth fibers of the internal anal sphincter IAS (about 0.5–1 mm), a layer of smooth fibers in a longitudinal direction (longitudinal muscle LAM, about 1 mm); all the above three layers (mucosa, IAS & LAM) continue above as the layers of the rectum ampulla. An outermost thicker layer (between 1 and 3 mm) of striated muscle fibers forms the external anal sphincter (EAS), which prolongs between the anal orifice and the puborectalis sling at the level of the anorectal angle. Therefore, the anal canal is surrounded by internal and external anal sphincters, which play an important role in the maintenance of fecal continence.

❖ The mucosa*:*

The mucosa of the anal canal is organized into longitudinal folds, known as anal columns. These are joined together at their inferior ends by anal valves. Above the anal valves are small pouches which are called anal sinuses – these contain glands that secrete mucus.

All the anal valves together form an irregular circle – known as the pectinate line (or dentate line). This line divides the anal canal into upper and lower parts, which differ in both structure and neurovascular supply ***(Mahadevan, 2010).*** This is due to their different embryological origins: **Above the pectinate line** (derived from the embryonic hindgut) and **below the pectinate line** (derived from the ectoderm of the proctodeum).

Agarwal (2012) described the anal columns and sinuses as a structure resembling an umbrella or an accordion wall. This structural feature might play a role in smooth expansion of the anal canal without overstretching the epithelium for defecation as well as for continence of feces and gas**.**

According to the character of the epithelial lining, the anal canal is divided into three zones; the colorectal zone, the anal transitional zone and the squamous zone.

• **The colorectal zone** was found in the upper third of the anal canal and contained simple columnar epithelium with characteristics identical to that of the rectum. The epithelium has secretory and absorptive cells with numerous tubular glands or crypts. The subepithelial tissues were mobile and relatively distensible, and contained submucosal arterial and venous plexuses ***(Tanaka et al., 2012)***.

• **Regarding the anal transitional zone (ATZ)**, ***Standring (2015)*** reported that it occupied the middle third of the anal canal. He added that it possessed a stratified columnar epithelium which represented a

transition between the simple columnar epithelium and the stratified squamous epithelium that extended to the cutaneous zone of the anal canal.

The stratified columnar epithelium was often connected to the excretory ducts of the anal glands or located close to the anal glands. The ATZ possessed three patterns of the epithelium; Pattern I showed stratified squamous epithelium alone and pattern II showed stratified columnar epithelium. Pattern III was composed of both stratified squamous epithelium and stratified columnar epithelium ***(Tanaka et al., 2012)***.

Barleben and Mills (2010) found that the anorectal line was the line at which the simple columnar epithelium in the rectum came to an end. Therefore, it seemed reasonable that the anorectal line was considered as the end of the large intestine. It was remarkable that the epithelium of the anal canal on the other side of this line was composed of one type of epithelium, the stratified squamous epithelium.

In addition, this area (which ends exactly at the anal intersphincteric groove) was accompanied by the muscularis mucosae, the circular muscle corresponding to the internal anal sphincter and the longitudinal muscle following those of the rectum. Therefore it is proposed that the area that begins at the anorectal line and ends at the anal intersphincteric groove with the internal anal sphincter muscle should be considered and treated as an organ against the rectum or the external skin. When we temporarily defined this organ as the anal canal, it seemed to be simple and easy to recognize ***(Tanaka et al., 2012)***.

• The third zone, **squamous zone** was described by ***Agarwal (2012***). It was found in the lower third of the anal canal. This zone was lined with stratified squamous epithelium continuous with that of the perineal skin.

The stratified squamous epithelium in the third zone appeared to be hard, suitable for the pathway of feces. The mucus was discharged not only from the anal glands but also from the domed crypts near the anorectal line that lubricate the surface of the anal canal for smooth defecation. In addition, the epithelium of the anal canal might also protect against invasion of antigens ***(Stanley et al., 2017)*.**

According to ***Thiruppathy* et al., (2017),** the defecatory function of the epithelium of the anal canal varied for each region. Observation from the rectum using an endoscope proposed that if the lower rectum was filled with feces or gas, the upper anal canal became slightly opened and so the epithelium might slide off the anal canal toward the lower rectum. At this time, feces or gas came in contact with the epithelium in the middle and lower zone with sensory nerves which could be one of the mechanisms of urgency and feces–flatus discrimination**.**

❖ The submucosa*:*

Agarwal (2012) described the submucosa of the anal columns as containing the terminal ramifications of the superior rectal artery and the rectal venous plexus. Enlargement of these submucosal veins constitute internal hemorrhoids, which are related to elevated venous pressure in the portal circulation (portal hypertension).

❖ Muscles of the anal canal:

It is well known that the muscles of the anal canal perform a critical role in maintaining continence. Any defect in their structure could negatively affect the physiological control of feces. ***Yu and Rao (2014)*** described the anal canal as a complex muscle that comprises both striated and smooth muscle. The anal canal is encircled by internal and external anal sphincters separated by the conjoint longitudinal muscle layer. The three muscles together are referred to as the anal sphincter complex.

- ***External anal sphincter***

The external anal sphincter was described as a band of striated muscle that surrounds the lowest part of the anal canal. The area of pigmentation of skin around the anal verge corresponds approximately to the extent of the external anal sphincter. ***Rociu et al., (2000)*** added that the external anal sphincter formed the main bulk of the anal sphincter complex. It is an oval tube of striated muscle composed mostly of type I slow twitch muscle fibers modified for prolonged contraction. The length and thickness of the external anal sphincter is less in females**.**

The uppermost (deepest) fibers intermingled with the lowermost fibers of puborectalis. Anteriorly, some fibers decussated into the superficial transverse perineal muscles. Posteriorly, fibers were attached to the anococcygeal raphe. The majorities of the middle fibers of the external anal sphincter surrounded the lower part of the internal sphincter and were attached anteriorly in the perineal body, and posteriorly to the coccyx via the anococcygeal ligament. Some fibers from each side of the