INTRODUCTION

Vesicovaginal fistula (VVF), which often manifests as total urinary incontinence, is a difficult problem that causes social and psychological distress to the patient**.** It remains one of the most challenging problems in modern female urology. Although it is not a life threatening problem, it significantly decreases a woman's quality of life (QoL) ***(Dmitri et al., 2009).***

Vesicovaginal fistula is a clinical condition characterized by continuous leakage of urine per vagina as result of abnormal communication between the urinary bladder and the vagina, it is the most common form of communication between efferent urinary passages and the genital tract ***(Munir-deen et al., 2002).***

From the earliest days of recorded medical history, physicians struggled with the problems of vesicovaginal fistula. It is one of the oldest recognized human diseases. It has been recognized since ancient times being noted in an Egyptian mummy dating back to 2000 BC ***(Riley, 2001).***

Avicenna, an Arabo-Persian physician, was the first person to document the relationship between vesicovaginal fistula and obstructed labor in 1037 AD ***(Zacharin, 2000).***

Although **James Marion Sims,** the father of american gynecology, is considered the pioneer of vesicovaginal fistula repairs, the history of surgical correction for this condition begins long before his time. The first documented attempt was in Amsterdam by **Hendrik van Roonhuyse** in 1663. He introduced innovations, such as proper surgical exposure and wound edge apposition, through the use of stitching needles. Using his technique, a Swiss physician named **Johann Fatio** successfully closed two fistulas in **1675. Peter Mettauer** of Virginia performed the first successful VVF closure in the United States in 1836. His achievement was soon repeated by **George Hayward** of Massachusetts in 1839 ***(Huang et al., 2002).***

Dr. **Sims** did not begin his unprecedented work in Alabama until 1845. Many modern advances developed soon afterwards.

Alwin Mackenrodt performed the first ‘‘layered’’ repair in 1894.

The most significant modern contribution came from Dr. **Heinrich Martius** in the late 1920s. His interposed labial fat graft paved the way for many of the techniques used in contemporary surgical repair of complex vesicovaginal fistulas ***(Huang et al., 2002).***

The causes of VVF include obstetric injury usually obstructed labor, iatrogenic surgical injury such as after hysterectomy or colon surgery & radiation therapy. While postpartum fistulas dominated in the earlier periods, lately postoperative fistulas became more frequent, all due to a considerably larger number of difficult and extensive surgeries of female genital organs, and more correct delivery management contributed to this ratio ***(Creanga et al., 2007).***

The frequency, etiology and presentation of VVF differ from country to country and within various region of the same country. WHO estimated that some 2.1 million women are living with fistula with an additional of 50, 000 - 100, 000 new cases per year ***(Wagan et al., 2006).***

Pelvic surgery is considered the most common cause of VVF in Western world. It is estimated that 0.5% to 2% of hysterectomies are complicated by vesicovaginal fistula. Fistula associated with total abdominal hysterectomy account for 75% of all fistulas in the developed countries ***(Huang et al., 2002).***

In the developing countries VVF are primarily associated with prolonged obstructed labor and traumatic delivery. Current estimates indicate that VVF occurs in one to three of every 1000 deliveries in West Africa. The true incidence in developing countries is unknown due to poor record-keeping. A conservative estimate reports that 3.5 million women in the developing world have unrepaired VVF fistula ***(Wall, 2006).***

Regardless of the etiology, most medical therapies have proven to be ineffective, and surgical correction remains the primary method for repairing vesicovaginal fistula, except in few cases where conservative measurements such as catheter drainage and/or cauterization of the fistula tract, are reserved for fistulas less than 5 mm. in otherwise healthy tissue ***(Karyn et al., 2003).***

Historically, there have been two operative approaches to repair vesicovaginal fistula by abdominal and vaginal route. Later on, considerable progress has been made with new suture materials and techniques. In last few decades, successful closure of vesicovaginal fistula has been reported with various rather less invasive techniques. These include laparoscopic and robotic repair, transurethral repair, laser welding and even closure with fibrin glue. However, these techniques have been used only for selected cases having small sized fistula ***(Christine et al., 2007).***

The approach chosen by the surgeon has been dictated by the location of the fistula. Traditionally the abdominal approach has been used for Supratrigonal fistula, whereas the vaginal approach has been used for Infratrigonal, bladder neck, and proximal urethral fistulas. Combined procedures are often reserved for complicated fistula ***(Huang et al., 2002).***

Furthermore, various grafts and flaps have been interposed between the bladder and vagina to promote healing and decrease the incidence of fistula recurrence. These interposition grafts and flaps have not been routinely used for first-attempt repairs when the surrounding tissues appear healthy and well-vascularized ***(Deena et al., 2001).***

Before VVFs surgery is done, a number of preoperative considerations must be addressed, including the etiology of the fistula, timing of surgery, vaginal versus abdominal approach, concomitant procedures, excision of the fistula tract, tissue interposition, sexual function and adjuvant treatment ***(Karyn et al., 2003).***

Multiple Factors could affect the outcome of VVF repair including : fistula size, degree of scarring of surrounding tissue, postoperative urinary catheter dwelling, postoperative radiotherapy, postoperative care and association with other serious injuries, such as a concurrent rectovaginal fistula or sphincteric damage ***(Wall et al., 2006).***

Farahat et al. defined the complex VVF as those 1.5 cm or larger in diameter, or those with failed previous repair trials. Fistula less than 1.5cm with widely scarred edges for which excision of the unhealthy, firm tissue would bring up a fistula greater than 1.5 cm was also included ***(Farahat et al., 2012)***.

These Complex VVF are usually associated with difficult dissection and/or approximation of the edges. Thus, most surgeons prefer to interpose vascularized grafts or flaps between the bladder and vagina in surgical correction to improve success ***(Mehmood et al., 2009).***

According to **Cron**, the benefits of grafting are better coverage of minor defects in the suture line and maintaining the healing of the bladder and vaginal wall apart, which limits the opportunity for communication during the healing process ***(Cron, 2003).***

In 1928 **Heinrich Martius** first described a pedicled fat flap harvested from the labia majora composed of fat and fibrous septa with few muscle fibers used to repair a large vesicovaginal fistula. Since that time, the Martius procedure has been performed for complex fistulas, including those due to radiation ***(Petrou et al., 2002).***

As soon as Martius reported the results of VVF repair using his flap, multiple reports have been published on VVF repair using various tissues for interpositioning, such as a peritoneal, omental, gracilis and gluteal flap ***(Karyn et al., 2003).***

Eilber et al. reported 10-year experience with the treatment of complex VVF with peritoneal or Martius flap interposition with a 96%, 97% success rate respectively. On the other hand, the success rate for surgical closure of complex VVF managed without interposition flaps was 63% to 75% in other series ***(Eilber et al., 2003).***

The Martius flap produces reliable results.However, it has some drawbacks, as it requires a second skin incision with its healing scar. Moreover it is not well suited for fistulas high in the vaginal vault as the vagina may be inadvertently shortened in an attempt to extend the flap from the labia to the proximal vaginal vault. Additionally extra operative time and surgical skills are required ***(Karyn et al., 2003).***

Although, to our knowledge it has not been reported previously, interposing an off-the-shelf graft seems much easier from the surgical point of view ***(Farahat et al., 2012).***

A biomaterial is defined as any natural or synthetic substance used in the treatment of a patient that interfaces with tissue at some stage**.** Biomaterials have been used in the urinary tract for many centuries and they have evolved from primitive metal tubes to complex coated polymeric materials. The ideal biomaterial for the urinary tract should incorporate certain features, such as biological inertia, resistance to infection and encrustation, stability following placement, no significant discomfort to the patient and availability at an affordable price ***(Darren et al., 2004).***

Small-intestinal submucosa (SIS) is a unique biomaterial that has been shown to induce tissue-specific regeneration in numerous organ systems. In the urinary tract, animal studies have demonstrated that SIS promotes functional bladder regeneration. Other preliminary studies have suggested that SIS may also be extremely useful for several other types of urologic surgery application where new tissue is needed or reinforcement of native structures is desired ***(Cheng et al., 2000).***

SIS is an acellular collagen matrix graft that is synthesized from porcine small intestine. It has the advantages of being non immunogenic, biodegradable and ready to use, and it has achieved previous successful functional outcomes when used in different urological procedures including urethral and incontinence operations, and even bladder augmentation ***(Ayyildiz et al., 2008).***

Since its discovery in 1987, many studies have defined its structure and have demonstrated its useful biointegration and tissue regeneration properties. It also appears to be a resistant substrate associated with a low risk of infection. The role of this matrix is still under investigation in many fields of surgery, but its value has been clearly established in urological and gynaecological surgery ***(Dedecker et al., 2005).***

AIM OF THE WORK

The aim of this work is to evaluate the efficacy of small intestinal submucosa (SIS) in complex VVF repair and to compare its results with the standard Martius flap as an alternative off-the-shelf interposition flap in the transvaginal repair of complex vesicovaginal fistula. As regards safety, operative time, hospital stay, post-operative pain and effectiveness of both approaches.

Chapter 1

FEMALE PELVIC FLOOR SURGICAL ANATOMY

The durable surgical repair of vesicovaginal fistula remains a significant challenge for many. The pelvic reconstructive surgeon needs an intimate knowledge of relevant surgical landmarks as well as a fundamental understanding of the biomechanics of pelvic organ support in order to successfully restore normal anatomy and function.

Rather than presenting a detailed description of female pelvic anatomy, this chapter provides a discussion of the contemporary understanding of female pelvic organ, with emphasis on the functional and surgical anatomy of the vagina, bladder, urethra, and pelvic floor **(Barber, 2005).**

A- Orientation of the bony pelvis

The pelvic bones are the ilium, ischium, pubic rami, sacrum, and coccyx. The bony pelvis is the rigid foundation to which all of the pelvic structures are ultimately anchored. In the standing woman, the pelvis is oriented such that the anterior superior iliac spine and the front edge of the pubic symphysis are in the same vertical plane, perpendicular to the floor **(Figure 1)**.

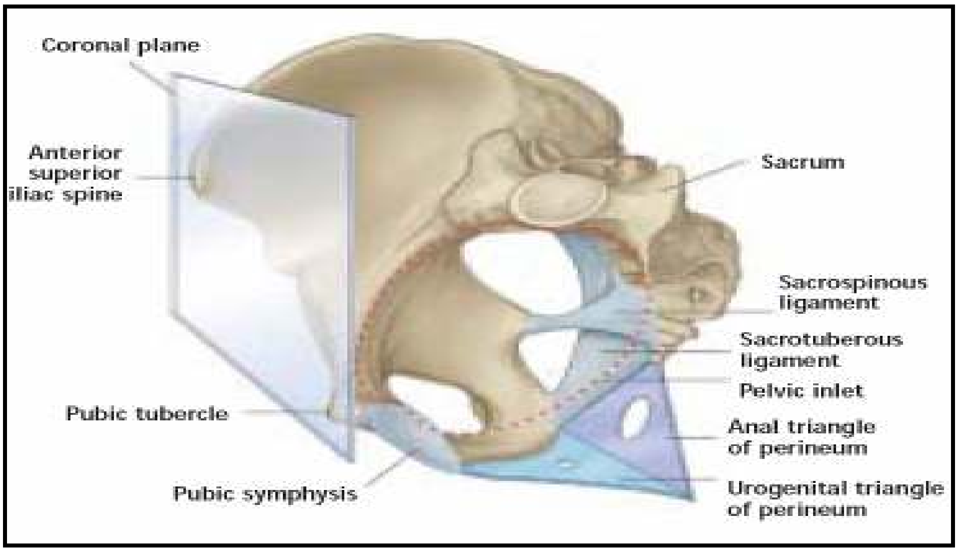

Figure (1): Orientation of the bony pelvis in the standing position.

As a consequence, the pelvic inlet is tilted anteriorly. In the upright position, the bony arches of the pelvic inlet are oriented in an almost vertical plane, this directs the pressure of the intra-abdominal and pelvic contents toward the bones of the pelvis and minimize the pressures on the muscles and endopelvic fascia ***(Mattox et al., 2000).***

B- Pelvic floor musculature

The pelvic floor consists of layers including:

a) The Endopelvic fascia:

This is the first layer of the pelvic floor configuration. The endopelvic fascia is the loose connective tissue network that envelops all of the organs of the pelvis and connects them loosely to the supportive musculature and bones of the pelvis.

Histologically, it is composed of collagen, elastin, adipose tissue, nerves, vessels, lymph channels, and smooth muscle. This connective tissue network attaches the vagina and uterus to the pelvic sidewall.Moreover, it allow the mobility of the viscera to permit storage of urine and stool, coitus & parturition ***(Barber, 2005).***

Several areas of the endopelvic fascia have been named by anatomists. These are condensations of the endopelvic fascia and not true “ligaments”: uterosacral ligament, Pubocervical fascia, Rectovaginal fascia, broad ligament, mesovarium, mesosalpinx, and round ligament ***(Herschorn, 2004).***

Arcus Tendineus Fascia Pelvis (ATFP) is a thickened whitish band in the upper layer of the diaphragmatic part of the endopelvic fascia.It joins the fascia of the pubocervical fascia that covers the anterior wall of the vagina ***(Abrams et al., 2005)*** **(Fig. 2).**

b) Pelvic diaphragm:

This is the second layer of the pelvic floor (Levator ani & coccygeus); it is a layer of striated muscle with its fascial covering. It acts as a horizontal shelf to support the pelvic organs.

The levator ani is a thin, broad muscle and characterized by fast twitch muscle fibers. It attaches to the inner surface of the side of the pelvis and unites with the other side to form the largest part of the pelvic floor. It has a critical role in supporting the pelvic visceral organs and play an integral role in urinary, defecatory, and sexual function, the levator ani muscle complex consists of the pubococcygeus, the puborectalis, and the iliococcygeus ***(Loubeyre et al., 2012).***

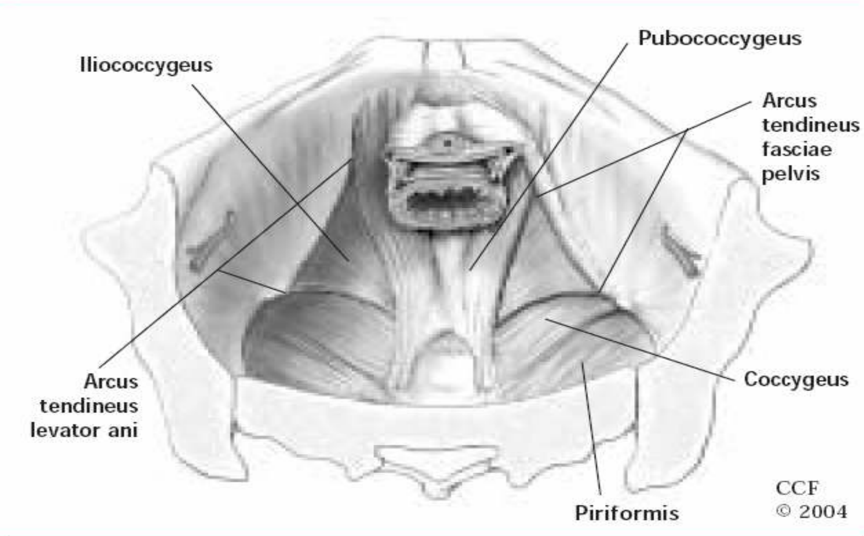

Figure (2): Illustration of the female pelvic floor showing relationships of the muscles of the pelvic floor and sidewalls and their attachments from an abdominal view. The arcus tendineus fasciae pelvis has been removed on the left, showing the origins of the levator ani muscles. On the right, the arcus tendineus fasciae pelvis remains intact, showing the attachment of the lateral vagina via the endopelvic fascia (cutaway).

The **pubococcygeus** originates on the posterior inferior pubic rami and inserts on the midline-visceral organs **(figure 2)**. The **puborectalis** also originates on the pubic bone, but its fibers pass posteriorly and form a sling around the rectum, resulting in the anorectal angle. The **iliococcygeus** originates from the arcus tendineus levator ani (ATLA), “a linear thickening of the fascial covering of the obturator internus“ inserted in the midline (levator plate). The space between the levator ani musculature through which the urethra, vagina and rectum pass is called the urogenital hiatus ***(Kearney et al., 2004).***

c) The urogenital diaphragm:

It is the third layer of the pelvic floor (perineal membrane and body). it consists of the superficial & deep transverse perineal muscles with their fascial covering ***(Brandon et al., 2009).***

Although the area between the vagina and anus is described clinically as the "perineum", however, anatomically the perineum is the entirety of the pelvic outlet inferior to the levator ani. A line connecting the ischial tuberosities divides the perineum into the urogenital triangle anteriorly and the anal triangle posteriorly ***(Barber, 2005).***

The perineal membrane is a thick fibrous sheet that spans the urogenital triangle, dividing it into a superficial perineal space contain the superficial perineal muscles, and deep perineal space containing deep perineal muscles **(Fig 3).**

Historically anatomists and clinicians have used the term urogenital diaphragm to describe the perineal membrane. However, this term has been abandoned because it describes a muscular diaphragm rather than a thick sheet of connective tissue ***(Mirilas et al., 2004).***

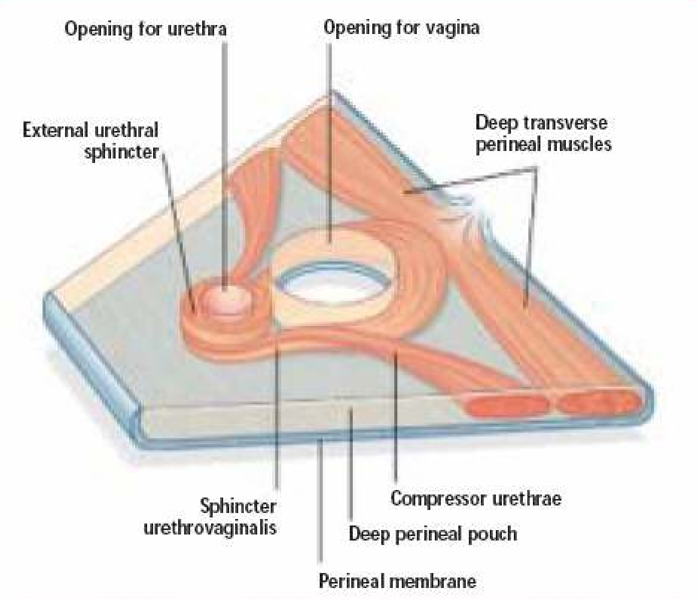

Figure (3): Muscles of the deep perineal space.

The perineal membrane provides support to the lower vagina and urethra by attaching these structures to the bony pelvis. The perineal body is a pyramid of connective tissue mass at the junction between the posterior vaginal wall and the anus, in the midline of the perineum ***(Yavagal et al., 2011).***

D) Innervation of the pelvic floor muscles.

The pudendal nerve (S2–S4) innervates the striated urethral and anal sphincters as well as the deep and superficial perineal muscles and provides sensory innervation to the external genitalia ***(Barber et al., 2002)***.