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Evaluation of functional, metabolic and morbidity outcomes of ileal orthotopic bladder substitution: A comparative study between studer, hautmann and U-shaped neobladder

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Abstract

Bladder cancer (BC) is the seventh most commonly diagnosed cancer in the male population worldwide, and it is the tenth when both genders are considered. The segments of bowel urologist's use most frequently are the ileum, colon, and rectum. The jejunum and stomach are also used, although less commonly, in reconstructive procedures. The orthotopic neobladder has become the procedure of choice for suitably selected patients. However, continent cutaneous reservoirs and ileal conduits remain important options and may be the most appropriate diversion in selected circumstances. Urinary diversions fall into two general categories: Continent and Incontinent diversions. The majority of studies have demonstrated the safety and functional benefits of orthotopic diversions; however, complication rates can be significant. Complications following orthotopic neobladder may be classified as early and late. The functional goals of an orthotopic neobladder are to maintain continence during both the day and night and to allow consistent emptying of the neobladder without the need for intermittent catheterization.

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1. Introduction

Bladder cancer is typically diagnosed in older individuals, with a median age at diagnosis of 69 years in men and 71 in women; the age of onset is younger in current smokers than in never smokers; although extremely rare, bladder cancer can be seen in children and young adults, where it usually presents with low-grade, non-invasive disease [1]. Removal of the bladder (cystectomy) necessitates reconstruction of the lower urinary tract; bladder cancer is the most common reason for cystectomy; however, the same principles apply to patients who undergo pelvic exenteration for other malignancies or who require cystectomy for non-malignant conditions in which conservative nonsurgical management has failed such as intractable gross hematuria, recurrent severe infections, medically refractory urinary incontinence, neurologic disorders and rarely chronic pelvic pain [2].

Orthotopic neo-bladders were initially limited to men while in women; urethra-sparing orthotopic substitution was thought to be associated with an increased risk of local recurrence and voiding dysfunction. However, as our understanding of the female rhabdoid sphincteric (continence) mechanism has improved, this approach has become technically feasible in women, and oncologic outcomes are not compromised [3].

1.1 Bladder cancer

Etiology and risk factors: Tobacco, occupational exposure, genetic, dietary habits**,** environmental exposure and other such as the impact of metabolic factors (body mass index, blood pressure, plasma glucose, cholesterol, and triglycerides) remains uncertain [4].

1.2 Diagnosis of bladder cancer

1.2.1 Symptoms

Painless visible hematuria is the most common presenting complaint. Other presenting symptoms and clinical signs include nonvisible hematuria, urgency, dysuria, increased frequency, and in more advanced tumors, pelvic pain and symptoms related to urinary tract obstruction [5].

1.2.2 Physical examination

Physical examination should include rectal and vaginal bimanual palpation; a palpable pelvic mass can be found in patients with locally-advanced tumors, in addition, bimanual examination under anesthesia should be carried out before and after transurethral resection of the bladder tumor (TURBT) to assess whether there is a palpable mass or if the tumor is fixed to the pelvic wall [6].

1.2.3 Cystoscopy

Ultimately, the diagnosis of BC is made by cystoscopy and histological evaluation of resected tissue, an (outpatient) flexible cystoscopy is recommended to obtain a complete image of the bladder; however, if a bladder tumor has been visualized unequivocally by imaging studies such as computed tomography (CT), magnetic resonance imaging (MRI), or ultrasound (US), diagnostic cystoscopy may be omitted and the patient can proceed directly to TURBT for histological diagnosis and resection; during the procedure, a thorough investigation of the bladder with rigid cystoscopy under anesthesia is mandatory in order not to miss any tumors at the level of the bladder neck [5].

1.2.4 Urine cytology

Positive voided urinary cytology can indicate a urothelial carcinoma anywhere in the urinary tract; negative cytology, however, does not exclude its presence; cytological interpretation is user-dependent, and evaluation can be hampered by low cellular yield, urinary tract infections, stones, or intravesical instillations: but for experienced hands specificity exceeds 90 % [7].

1.2.5 Imaging

Imaging is used to evaluate the upper urinary tract and the presence of regional or distant metastases; computed tomography is unable to differentiate between stages from Ta to T3a tumors, but it is useful for detecting invasion into the perivesical fat (T3b) and adjacent organs; the accuracy of CT in determining extravesical tumor extension varies from 55% to 92% and increases with more advanced disease [8].

1.2.6 Grading and staging

Pathological staging: The Tumor Node Metastases (TNM) classification of malignant tumors is the method most widely used to classify the extent of cancer sprea [9].

1.2.7 Treatment of bladder cancer

Treatment of non-muscle invasive (NMIBC) bladder cancer: The initial treatment of non-muscle invasive bladder tumors is a complete transurethral resection of bladder tumors (TURBT), which is usually carried out at the time of diagnosis; many patients can be successively managed with a localized resection, and more aggressive surgical resection should be deferred whenever possible [10].

1.2.8 Treatment of muscle invasive (MIBC) bladder cancer

Radical cystectomy (RC) with bilateral pelvic lymphadenectomy and urinary diversion has been the mainstay of treatment for localized MIBC and for non-muscle invasive bladder cancer that is refractory for intravesical therapy [11]. Standard pelvic lymphadenectomy in bladder cancer patients involves removal of nodal tissue cranially up to the common iliac bifurcation, with the ureter being the medial border, including the internal iliac, presacral, obturator fossa and external iliac nodes; the lateral border is the genitofemoral nerve, caudally the circumflex iliac vein, the lacunar ligament and the lymph node of Cloquet [12]. Urinary diversion is performed in either a non-continent or continent fashion. Non continent diversion as ureterocutaneostomy, ileal or colonic conduit while continent diversion as orthotopic bladder, ureterosigmoidostomy or continent cutaneous reservoirs and several studies have compared advantages and disadvantages in terms of QoL (quality of life), sexual function, urinary continence and body image between different urinary diversions [13]. Minimally invasive RC: Traditionally, radical cystectomy has been performed with an open surgical approach; laparoscopic or robotic radical cystectomy has been investigated as a minimally invasive alternative, with the potential for reduced morbidity and more rapid convalescence without compromising oncologic efficacy [14]. Sexual-preserving techniques**:** different approaches have been described to improve voiding and sexual function in patients undergoing radical cystectomy; no consensus exists regarding which approach preserves function best; concern remains regarding the impact of 'sparing-techniques' on oncological outcomes; there are four main types of sexual-preserving techniques in male patients have been described [15]. Prostate sparing cystectomy, capsule sparing cystectomy, seminal sparing cystectomy and nerve-sparing cystectomy. While in female patients, pelvic organ-preserving techniques involve preserving the neurovascular bundle, vagina, uterus, ovaries or variations of any of the stated techniques [15]. Bladder preservation strategies**:** the risk of perioperative morbidity associated with radical cystectomy and the substantial impact of urinary diversion requiring an external appliance on health-related quality-of-life has led to the use of less radical approaches for the management of patients with muscle-invasive bladder cancer; for patients who are elderly or have significant comorbid illnesses and for those who desire to preserve their bladders, alternatives to radical cystectomy include: Partial cystectomy, Radiation therapy (RT) techniques and Radical transurethral resection [16, 17]. Radical cystectomy: morbidity and mortality: Common complications include ileus, atelectasis, DVT (deep venous thrombosis), and wound infection; less common complications include rectal injury, uretero-ileal anastomotic leaks, and bowel obstruction; lymphadenectomy typically carries a low morbidity rate; in a large series that detailed complication rates directly attributable to the lymph node dissection, about 5% of patients had prolonged lymphatic drainage via an externalized tube; rectal injury results from undue excessive traction of the specimen, which can cause tenting and avulsion of rectal tissue or direct incision into the rectum [18].

1.3 Surgical Anatomy of gastrointestinal segments used for urinary diversion.

Selecting gastro- intestinal segment: The stomach, jejunum, ileum, and colon have unique properties, each of which has special advantages and disadvantages; the selection of the proper intestinal segment should be based on

the patient's condition, renal function, history of previous abdominal procedures, and type of diversion or substitution required [19].

1.3.1 Stomach

The advantages of the stomach over other intestinal segments for urinary diversion: it is less permeable to urinary solutes, it has a net excretion of chloride and protons rather than a net absorption of them and it produces less mucus; electrolyte imbalance rarely ensues in patients with normal renal function, although hypochloremic metabolic alkalosis possible [19].

1.3.2 Specific complications

Hematuria-dysuria syndrome: in approximately 24% cases, symptoms (suprapubic, penile, peri-urethral pain; gross hematuria without infection, skin excoriation, dysuria without infection), symptoms are typically intermittent and self-limiting, and can usually be controlled with H2 blockers; Severe metabolic alkalosis associated with respiratory distress [19].

1.3.3 Jejunum

Usually not used due to severe electrolyte imbalance; in general, diseases that would make the ileum inappropriate for use also make the jejunum inappropriate for use; rarely, it is the only segment available, under these circumstances, as distal a segment of jejunum as possible should be used to minimize the electrolyte problems[19].

1.3.4 Ileum

Used most often for urinary tract reconstruction; the ileum is mobile, has small diameter and a constant blood supply; loss of significant portions of the ileum results in vitamin B12 deficiency, diarrhea due to lack of bile salt reabsorption and fat malabsorption [19].

1.3.5 Colon

Requires mobilization from its fixed positions to give it the mobility necessary for use in urinary reconstruction; it has a larger diameter than the ileum and is usually easily mobilized into any area of the abdomen or pelvis; in pelvic irradiated cases, portions of the right, transverse, and descending colon may be used [19].

1.3.6 Urinary diversions

Urinary diversions fall into two general categories: Incontinent diversions in which urine continually drains requiring an external appliance on the skin surface for urine collection such as cutaneous ureterostomies, ileal or colonic conduit; and continent diversions in which urine is collected and stored internally and are intermittently emptied either by catheterization or volitional voiding, freeing the patient from the ne ed for an external appliance such as ureterosigmoidostomy, continent cutaneous reservoirs and an orthotopic neo-bladders [20].

Ideal characteristics of a urinary reservoir: Low pressure system, stores a functional amount of urine (approximately 500 mL), complete continence, complete voluntary control of voiding and no absorption of urinary waste products by the reservoir walls.

1.3.7 Ureterocutaneostomy

In a retrospective comparison with short follow-up, the diversion-related complication rate was considerably lower for ureterocutaneostomy compared to ileal or colon conduit [21].

1.3.8 Ileal conduits

Ileal conduits were the gold standard for urinary reconstruction until the introduction and subsequent acceptance of continent diversions; the ileal conduit remains the procedure of choice for patients with a short life expectancy and for those who cannot complete the rehabilitation and subsequently manage a continent diversion [22].

1.3.9 Outcomes

One study of 131 patients who underwent ileal conduit reconstruction and survived at least five years demonstrated an overall complication rate of 66 percent. [22].

1.3.10 Ureterosigmoidostomy

Ureterosigmoidostomy was the first widely used surgical technique for urinary diversion; however, this approach has been defined a series of complications that guided subsequent surgical progress: gradual deterioration of renal function, hyperchloremic metabolic acidosis and development of secondary cancers in the sigmoid colon near the site of ureteral implantation [23].

1.3.11 Continent cutaneous diversions

All continent cutaneous reservoirs rely upon a low-pressure pouch constructed of various detubularized bowel segments and a functional mechanism that connects the reservoir to the skin, designed to prevent involuntary urine flow; reservoirs differ based upon the type of valve mechanism constructed and the exact segment of intestine utilized; many technical variations exist; examples include the Kock, Indiana, and Miami pouches; the most obvious advantages of this type of diversion are the ability to avoid continuous urine drainage and the need for an external appliance [24].

1.3.12 Orthotopic bladder substitutes

Many methods for construction of an orthotopic neobladder using intestinal segments exist, but three basic principles must be satisfied for a successful outcome: the patient must have an adequate external sphincter mechanism and non-obstructed urethra; the reservoir must be sufficiently compliant to maintain a low pressure throughout the filling phase; and The reservoir must have adequate volume to allow for reasonable voiding intervals, in general, this should be at least 300 to 500 mL once the pouch is mature; all bowel segments effectively stretch over time if there is adequate outflow resistance [25].

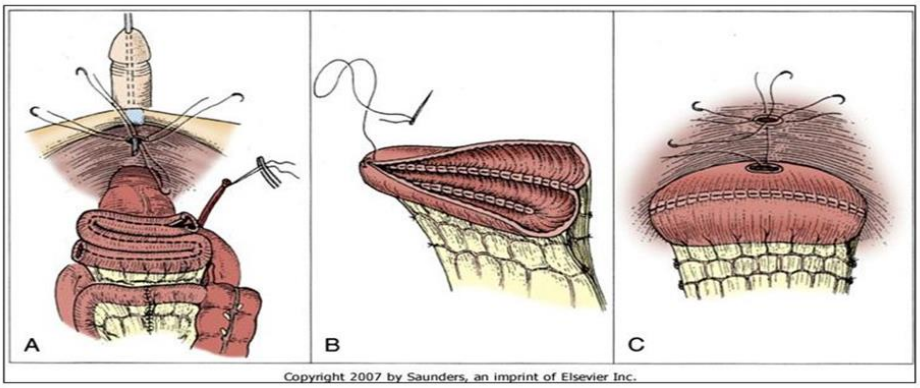

Figure 1: Construction of the modified Camey II [26].

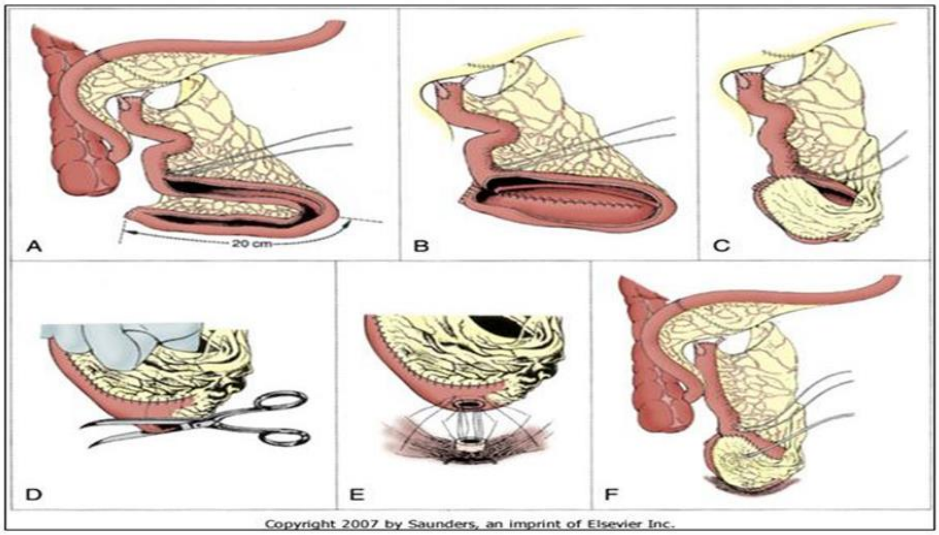

Figure 2: Construction of Studer pouch [27].

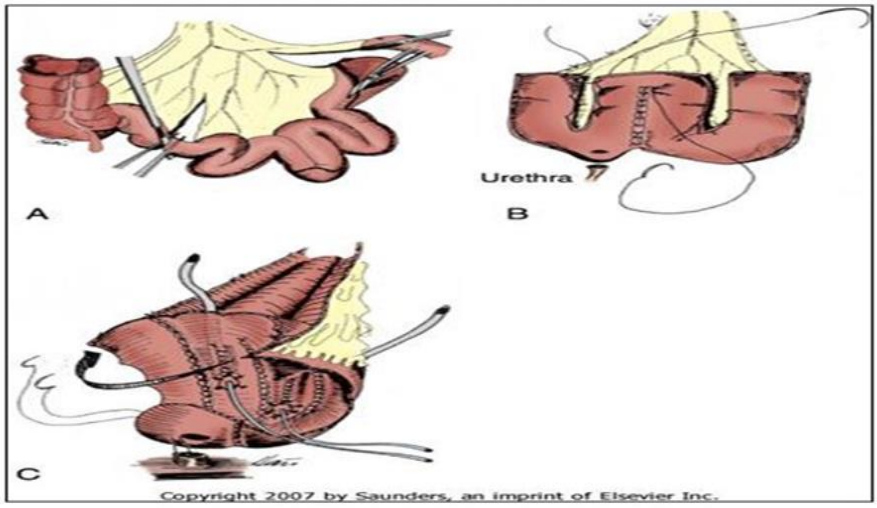

Figure 3: Construction of Hautmann pouch [28].

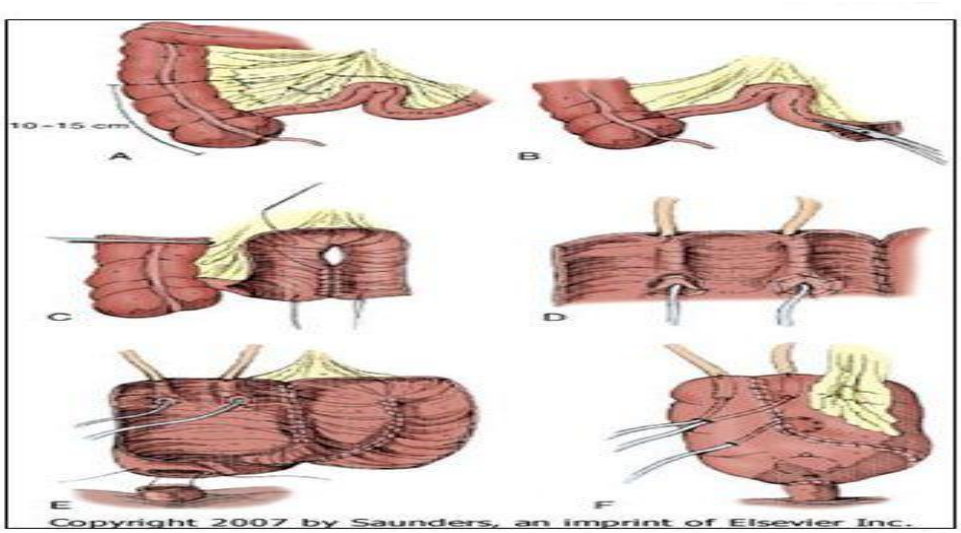

Figure 4: Construction of the Mainz pouch [29].

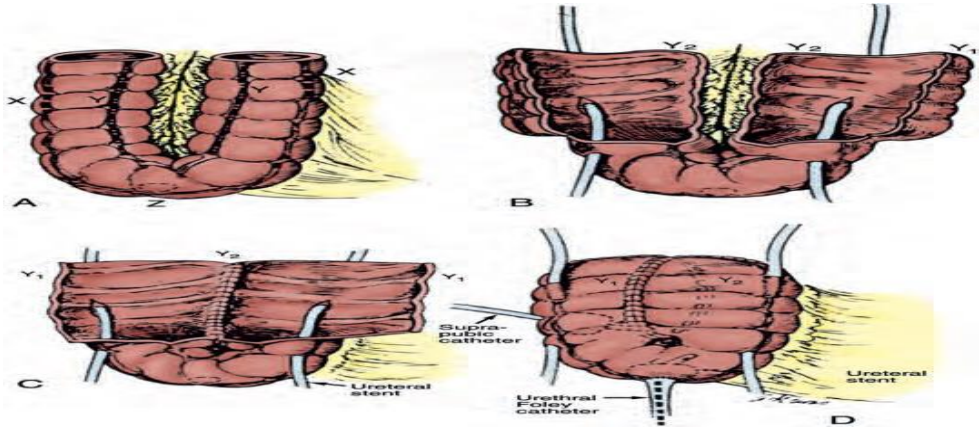

Figure 5: Construction of Reddy pouch [30].

1.4 Types of neo- bladders reconstruction

Ileal neobladder includes Camey I and II (U-shaped), modified Camey II (Z-shaped), Kock, T-pouch, Studer, Hautmann (W-shaped) and the Abol-Enein and Ghoneim modification of the W pouch; ileocolonic neobladders include: the Mainz pouch and Le Bag pouch; and Sigmoid neobladder: such as the Reddy pouch.

1.5 Examples of ileal reservoirs

1.5.1 Construction of the modified Camey II

A, the ileal loop is folded three times (Z shaped) and incised on the antimesenteric border. B, the reservoir is closed with a running suture to approximate the incised ileum. C, The urethroenteric anastomosis is performed [26].

1.5.2 Construction of Studer pouch

The ileal bladder substitute as initially described by Studer and colleagues used a long, afferent, isoperistaltic, tubular ileal segment, it is believed that the long segment functionally prevents vesicoureteral reflux when the patient voids by Valsalva maneuver; the advantages of this bladder substitute include the simplicity of construction, the lack of a requirement for surgical staples, and the ability to accommodate short ureters [27]. A, A 60- to 65-cm distal ileal segment is isolated (approximately 25 cm proximal to the ileocecal valve) and folded into a U configuration. Note that the distal 40 cm of ileum constitutes the U shape and is opened on the antimesenteric border; the more proximal 20 to 25 cm of ileum remains intact (afferent limb). B, the posterior plate of the reservoir is formed by joining the medial borders of the limbs with a continuous running suture. The uretero-ileal anastomoses are performed in a standard end-to-side technique to the proximal portion (afferent limb) of the ileum. Ureteral stents are used and brought out anteriorly through separate stab wounds. C, the reservoir is folded and oversewn (anterior wall). D, before complete closure, a buttonhole opening is made in the most dependent (caudal) portion of the reservoir. E, the urethral anastomosis is performed. F, A cystostomy tube is placed, and the reservoir is closed completely [27].

1.5.3 Construction of the Hautmann neobladder

A, A 70-cm portion of terminal ileum is selected. Note that the isolated segment of ileum is incised on the

antimesenteric border. B, The ileum is arranged into an M or W configuration with the four limbs sutured to one another. C, after a buttonhole of ileum is removed on an antimesenteric portion of the ileum, the urethral anastomosis is performed. The ureteral anastomoses are performed using direct implantation and stented and the reservoir is then closed in a side-to-side manner [28].

1.6 Examples of colon and ileocolic pouches

1.6.1 Construction of the Mainz pouch

A, an isolated 10 to 15 cm of cecum in continuity with 20 to 30 cm of ileum is isolated. B, the entire bowel segment is opened along the antimesenteric border. Note that an appendectomy is performed. C, the posterior plate of the reservoir is constructed by joining the opposing three limbs together with a continuous running suture. D, an anti-reflux implantation of the ureters through a sub-mucosal tunnel is performed and stented. E, A buttonhole incision in the dependent portion of the cecum is made that provides for the urethra-enteric anastomosis. Note that the uretero-colonic anastomoses are performed before closure of the reservoir. F, the reservoir is closed side to side with a cystostomy tube and the stents exiting [29].

1.7 Examples of sigmoid pouch

1.7.1 Construction of Reddy pouch

A, A 35-cm segment of descending and sigmoid colon is isolated and folded into a U shape. B, the colon is incised along the medial taenia down to a point a few centimeters short of the entire colon. A buttonhole is made in the caudal portion of the colon that is later anastomosed to the urethra. C, the medial portions of the U are sewn together, and a tunneled ureterocolonic anastomosis is performed. D, the colonic pouch is closed by folding the reservoir side to side, and it is anastomosed to the urethra [30].

1.8 Complications of orthotopic bladder substitutes

Complications following orthotopic neobladder may be classified as early and late.

1.8.1 Early complications

Typically defined as occurring within 30 days of surgery, although some authors consider the “early postoperative period” to be 60 or even 90 days following surgery [31]. Early complications include anastomotic leakage, acute kidney injury (AKI), wound infection/dehiscence, prolonged ileus, and complications that may occur following any major surgery such as bleeding, sepsis, deep vein thrombosis, cardiovascular complications, and respiratory complications as pneumonia [32].

1.8.2 Late complications

Include uretero-ileal obstruction, incontinence, urinary retention, acute pyelonephritis and urosepsis, metabolic changes, deterioration of renal functions, upper tract and pouch stones, urethral stricture, pouch rupture, incisional hernia, and fistula formation [33].

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