SURGICAL TECHNIQUE

Indiana continent catheterizable urinary reservoir

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KEYWORDS
Bladder cancer; Uterine-cervical cancer; Pelvic exenteration; Radiotherapy; Bladder reconstruction; Continent reservoir; Indiana pouch

Abstract
Introduction: Radical pelvic surgery requires continent or incontinent urinary diversion. There are many techniques, but the orthotopic neobladder is the most used. A continent catheterizable urinary reservoir is sometimes a good alternative when this derivation is not possible or not indicated. This paper has aimed to present our experience with the Indiana pouch continent urinary reservoir.

Materials and methods: The series is made up of 85 patients, 66 women and 19 men, with a mean age of 56 years (31–77 years). Variables analyzed were operating time, estimated blood loss, transfusion rate, hospital stay and peri-operative complications.

Results: The main indication in 49 cases was resolution of complications related to the treatment of cervical cancer. Average operation time was 110.5 minutes (range 80–130 minutes). Mean blood loss was 450 cm\(^3\) (100–1000 cm\(^3\)). Immediate postoperative complications, all of which were treated medically, occurred in 16 patients (18.85%). One patient suffered anastomotic leakage. Hospital stay was 19 days (range 5–60 days) and there was no mortality in the series. Late complications occurred in 26 patients (32%), these being ureteral anastomotic stenosis in 11 cases, cutaneous stoma stenosis in 9 cases and reservoir stones in 6 cases.

Conclusion: The Indiana continent catheterizable urinary reservoir is a valid option for the treatment of both urological and gynecological malignancies as well as for the management of pelvic morbidity related to the treatment of pelvic cancers.

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PALABRAS CLAVE
Cáncer vesical; Cáncer cérvico-uterino;

Reservorio urinario continente cateterizable de Indiana

Resumen
Introducción: La cirugía radical pélvica requiere de una derivación urinaria, incontinente o continente. Existen numerosas técnicas, siendo la más utilizada la neovejiga ortotópica.

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Exanteración pélvica; Radioterapia; Reconstrucción vesical; Reservorio continente; Reservorio de Indiana

En ocasiones, cuando esta derivación no es posible o no está indicada, un reservorio urinario continente es una buena alternativa. El objetivo de este trabajo es presentar nuestra experiencia con el reservorio urinario continente de Indiana.

**Material y métodos**: La serie está constituida por 85 pacientes, 66 mujeres y 19 hombres, con una edad media de 56 años (31 a 77 años). Las variables analizadas fueron el tiempo operatorio, la pérdida sanguínea, la tasa de transfusión, la estancia hospitalaria y las complicaciones perioroperatorias.

**Resultados**: La indicación principal fue la resolución de complicaciones derivadas del tratamiento del cáncer cérvico-uterino en 49 casos. La duración media de la derivación urinaria fue de 110,5 min (rango 80-130 min). El sangrado promedio fue de 450 cc (rango 100-1.000 cc). Hubo complicaciones postoperatorias inmediatas en 16 pacientes (18,85%), todos tratados de manera médica. Un paciente tuvo una fistula anastomótica. La estancia hospitalaria fue 19 días (rango 5-60 días). No hubo mortalidad en la serie. Complicaciones alejadas ocurrieron en 26 pacientes (32%): estenosis de la anastomosis ureteral en 11 casos, estenosis del estoma cutáneo en 9 casos y litiasis del reservorio en 6 casos.

**Conclusión**: El reservorio urinario continente y cateterizable de Indiana es una opción válida para el tratamiento de neoplasias urológicas o ginecológicas, y también para el manejo de enfermedades pélvicas relacionadas con complicaciones del tratamiento de cánceres pélvicos.

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**Introduction**

Radical pelvic surgery, either radical cystectomy or anterior exenteration, is the treatment of choice for the primary treatment of infiltrating bladder carcinoma and for gynecological cancer. Total pelvic exenteration has also been used for recurrent cancer of the cervix, rectum, vagina, uterine corpus, vulva, prostate, bladder and for pelvic sarcomas.1,2

When this kind of surgery is performed, it is necessary to bypass both the urinary tract and occasionally the rectal tract too. In the case of urinary diversions, the urological history is long. Simon first performed diversion in the year 1892 in children with bladder extrophy (ureterosigmoidostomy).3

Bricker et al., in the year 1950, described the ileal conduit (also known as Bricker’s operation), thus marking one of the most important chapters in modern urology, this being one of the urinary diversions still commonly used after radical pelvic surgery.4 The history of continent, catheterizable urinary diversions began with Kock et al. in the 1970s, when they presented their technique of the ileoanal reservoir (Kock Pouch) for patients who had undergone total colectomy, introducing the concept of detubulization.5

This kind of reservoir was later applied to urinary tract diversions,6 and Hinman et al. were the ones who described the basic principles for configuring high-capacity, continent, non-refluxing urinary reservoirs and with an adequate adaptation to increasing urinary volume, with low intraluminal pressure, by studying their geometric capacity, adaptation and contractility. Toward the end of 1980, Hautmann et al. adapted this reservoir and anastomosed it to the urethra, thus introducing the concept of urinary diversion or orthotopic neobladder.6,9

Orthotopic bladder reconstruction with bowel transfer gained popularity in the 1990s, gradually becoming a procedure of choice in selected patients.10

The continent, catheterizable urinary reservoir introduced by the University of Indiana, described by Rowland et al. in the year 1987,11 was presented as a good urinary diversion alternative, their initial series showing that it was technically reproducible, with a low complication rate and a high continence rate.12

Our aim was to present the results of a personal series using the Indiana urinary reservoir, within a period of 20 years and applied to 85 patients who had undergone surgery consecutively.

**Materials and methods**

We analyzed a total of 85 patients with Indiana continent urinary reservoirs, in the period between 1991 and 2011. The inclusion criteria were the resolution of complications derived from uterine cervical cancer, infiltrating bladder carcinoma, and other types of pelvic malignancies. The information was prospectively registered and data were retrospectively analyzed. The analyzed variables were operative time, blood loss, transfusion rate, hospital stay, and perioroperative complications. The latter were standardized using the Clavien classification as modified by Dindo.13

**Surgical technique**

The day before surgery preparation is carried out with oral Fleet Fosfosoda®. Antibiotic prophylaxis begins at the moment of anesthetic induction with first-generation cephalosporin and metronidazole, which is repeated 3 h after surgery. Deep vein thrombosis prophylaxis is carried out with low-molecular-weight heparin, which is started 6 h before surgery and continues in the post-surgery period, and intermittent pneumatic compression of the lower limbs during the surgical operation.

Once pelvic time, radical cystectomy or pelvic exenteration have been performed, urinary diversion is performed. To do so, the ascending colon is sectioned on the right of the middle colonic artery and the terminal ileum, at
approximately 15–20 cm from the ileocecal valve. The reconstitution of transit is performed through lateral-end or latero-lateral anastomosis, interchangeably using mechanic suture with the Barcelona anastomosis technique or 2 mucosal and sero-muscular planes with Monocryl 5-0© continuously.

The colonic segment is detubulized with an electric scalpel, through the anterior tenia, until reaching the cecal pole. The proximal end (hepatic flexure) is moved to the cecal pole in order to form a spherical reservoir, first suturing a side with continuous Monocryl 3-0©. The left-sided ureter is pulled to the right beneath the mesosigma and mucosa-to-mucosa, direct anastomosis is performed, with separate stitches of Monocryl 5-0©. Each one is intubated with a 8-Fr feeding tube, which is extracted through a counter-opening. The cecal appendix, if it does exist, is removed, and a 20-Fr Malecot or Pezzer catheter, which will serve as drainage of the cystectomy type, is placed in this area. The closure of the bag is now completed with the same Monocryl 3-0© suture. The ileal continent valve is then made. To that end, a 12-Fr Nelaton catheter is placed in the ileum and it is attached to the mesenteric edge with Babcock clamps. In order to achieve a reduction of the ileal light, plica-tion was performed with separate 2-0 silk stitches or with a linear stapler-cutter (used in the last 30 cases of the series) (Fig. 1). The reservoir is left on the right flank, and the urethral catheter-tutors and the cystectomy tube are externalized through a counter-opening on the abdominal wall, both of them through the right flank (Fig. 2). The cystostomy tube is pulled, thus fixing the reservoir to the abdominal wall. The deepest part of the belly button is grasped with a Kocher clamp and is circularly sectioned up to the peritoneum. The contracted ileum (continent valve) is externalized, fixing it flat to the navel skin with separate 3-0 Vicryl stitches©. This step is made at the time of closing the abdominal wall, in such a way that the ileum is left completely straight. A 18-Fr Nelaton catheter is left through it (Fig. 3).

The urethral catheter-tutors are removed on day 12, and the Nelaton umbilical catheter on day 15. At this point, the patient is trained in self-catheterization through the

Figure 1 shows the making of the continent ileal valve (arrow), this time made with linear cutter stapler.

Figure 2 Indiana reservoir completed. C: cystostomy; IR: Indiana reservoir; UT: ureteral tutors; CIV: continent ileal valve (in this case performed with plication with 2-0 separated silk sutures).

Figure 3 Final appearance of the surgery. C: cystostomy; D: drainage; SS: skin stoma with Nelaton 18 Fr probe; UT: ureteral tutors.

Figure 4 Late appearance of surgery with the flat stoma at the umbilical level.
umbilical valve, and the cystostomy catheter is removed once self-catheterization skills have been checked (Fig. 4).

Results

The sample comprises a total of 85 continent urinary reservoirs, 66 women and 19 men, with an average age of 56 years (range 31–77 years).

The main indication was the resolution of complications derived from the treatment for uterine cervical cancer (radical hysterectomy + pelvic radiotherapy) in 50 cases (vesicovaginal-rectal fistula in 25 cases, vesicovaginal fistula in 19 cases and actinic microbladder in 6 cases). Both in the case of vesicovaginorectal fistulae and in the case of vesicovaginal fistulae, severe actinic damage of the pelvis prevented them from being locally repaired.

The other patients corresponded to radical cystectomy or anterior exenteration due to infiltrating bladder carcinoma in 23 cases, anterior exenteration due to recurrent uterine cervical cancer in 6 cases, de-diversion in 3 cases and relapsed rectal carcinoma, pelvic sarcoma, and the development of orthotopic neobladder-vaginal fistula in one case, respectively. Demographic features are summarized in Table 1.

The surgery performed was only diversion with Indiana pouch in 49 patients, whilst it was associated with radical cystectomy or anterior exenteration in 24 patients and anterior or total pelvic exenteration in 8 patients (rescue of relapsed uterine cervical cancer in 6 cases, relapsed rectal cancer in one case, and a case of pelvic sarcoma). Urinary de-diversion of the ileal conduit, gastrocystoplasty and Mainz pouch II were performed in 3 patients, respectively. In the case of the patient with an orthotopic neobladder-vaginal fistula, who had been referred from another center, we performed a resection of the neobladder and new urinary diversion to Indiana pouch. In addition to urinary diversion, we performed colo-anal descent (Parks operation) in 25 patients with complex vesicovaginorectal fistula.14

The average duration of surgery, when only urinary diversion was performed without pelvic time, was 110.5 min (range 80–130 min). In the cases of urinary diversion, bleeding was minimal. When associated with pelvic time (exenteration, cystectomy), the average bleeding was 450 cm² (range 100–1000 cm²). Red blood cell transfusion was necessary in 23 patients (29.2%) (all patients with pelvic surgery).

Immediate postoperative complications occurred in 16 patients (18.8%): urinary sepsis in 5 (Clavien II), surgical wound infection in 4 (Clavien I), deep vein thrombosis in 3 (Clavien II), and lung atelectasis in 3 patients (Clavien I), all of whom were medically treated. A patient (cystectomy due to actinic microbladder) had a fistula from an ileocolonic anastomosis with secondary peritonitis, which required reoperation with ileostomy and mucous fistula (Clavien III-b), transit being reconstituted at 4 postoperative months.

Hospital stay was 19 days (range 5–60 days) and there was no mortality in the series. Mean follow-up was 56.3 months (range 7–151 months). Delayed complications related to the reservoir occurred in 26 patients (32%) and they were the following: stenosis of the urethral anastomosis in 11 renal units of 11 patients, stenosis of the skin stoma in 9 cases, and lithiasis of the reservoir in 6 cases.

Discussion

Since its description in 1987 by Rowland et al., the reservoir of the Indiana University group has proven to be a good urinary diversion with functional results similar to those of orthotopic diversions,15 and most of the published series show low complication rates.12,16–19

Variations of the Indiana pouch have been described, such as the California or double-T-pouch, the Mainz pouch I, the Florida and Miami pouch (variations of the Indiana pouch), and the Penn pouch (the first using the appendix as a catheterizable segment).20

In 1991, we decided to opt for using the Indiana continent urinary reservoir, since it seemed a reproducible technique and with good published results. Our first indication was for the treatment of severe complications derived from the treatment of cervical uterine cancer, patients that comprise the largest number in our series. Although in cases of radical surgery due to bladder cancer, our first choice is an orthotopic neobladder, when it is not feasible, the Indiana pouch is, for us, a very good choice versus the incontinent ileal conduit.

Gutiérrez-Godines et al.21 described their experience with the Indiana pouch in 32 patients, with a complication rate of 35%, and urinary tract infection being the most common one. Holmes et al.,21 in the year 2002, reported a total of 125 patients, this being one of the most extensive series ever published. With an average follow-up of 41.1 months, the high rate of long-term complications, such as urethral stenosis, lithiasis, incontinence, fistulae and urethral reflux, is striking. This is radically different to our experience.

As in our series, most of the studies have reported low complication rates. Table 2 shows a comparison of delayed complications in the series with a greater number of patients found in the literature.12,16–19

A particularly relevant aspect is the indication of surgery, since great diversity is observed in the literature.23 Considering that the currently most commonly used urinary

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diversion is the orthotopic neobladder10, the Indiana pouch also has its own indication in patients with urethral complications due to bladder carcinoma and in patients with in situ carcinoma (ISC), since it has been shown that in these cases there is a higher risk of early, delayed urethral complications.24,25 Another significant aspect is its use in women, since 30–40% of them will require self-catheterization in case of choosing an orthotopic neobladder, this being more difficult especially in obese patients.

What makes our series specific and distinctive is that most of the Indiana diversions were performed in patients with severe pelvic sequelae (bladder, vagina and rectum) secondary to the treatment of a gynecologic cancer. A similar series by Houvenaeghel et al.26 described a series of 124 patients who underwent pelvic exenteration followed by urinary diversion due to gynecologic malignancies. 72.5% of the patients had received previous radiotherapy with an overall complication rate of 52%.

In our experience, the Indiana pouch was a reproducible procedure with a low complication rate, especially in an important group of patients with severe sequelae derived from the treatment of uterine cervical cancer.

### Conclusion

The reconstruction of the urinary tract with the Indiana continent urinary reservoir is a reproducible, alternative urinary diversion and with a low rate of early and delayed complications. It is a valid option for the treatment of urologic or gynecologic malignancies, and also for the management of pelvic diseases related to complications of oncological pelvic treatments.

### Conflict of interest

The authors declare that they have no conflict of interest.

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