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RESEARCH ARTICLE

Assessing Functional Outcomes and Complications of Studer Ileal Neobladder: A Longitudinal Monocentric Study

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ABSTRACT

Introduction: **Studer-type enterocystoplasty represents a urinary diversion technique recommended following cystectomy in the treatment of bladder tumors. Its primary goal is to establish an internal continent neo-reservoir that closely mimics the characteristics of a normal bladder, enabling patients to maintain a regular lifestyle without compromising body image. The study aimed to assess the functional outcomes and morbidity associated with Studer ileal neo-bladder procedures performed at a single center.**

Methods: **Our study took place in the urology department of our hospital from January 2015 to September 2022, involving 26 patients who underwent Studer-type enterocystoplasty.**

Results: **No intraoperative or early postoperative deaths were recorded. The early complications rate stood at 26.9%, with 10 instances observed in six patients. These complications included four cases of acute pyelonephritis (15.4%), three incidents of parietal infections (11.5%), one leaky pouch (3.8%), paralytic ileus (3.8%), and urinary retention due to a mucous plug (3.8%). The number of late complications was 18 in 12 patients, resulting in a rate of 46.1%. These included two cases of uretero-neovesical stenosis (7.7%), two instances of neobladder lithiasis (7.7%), one case of upper urinary tract lithiasis (3.8%), eight cases of recurrent pyelonephritis (30.7%), and five cases of chronic metabolic acidosis (19.2%). Functional results were assessed twice: at 12- and 24-months post-surgery. The daytime continence rates at 12 and 24 months were 69.5% and 90%, respectively, while the night-time continence rates were 65.2% and 81%.**

Conclusion: **Studer-type enterocystoplasty stands out as one of the most effective urinary diversion methods in terms of surgical treatment for bladder tumors due to the highly satisfactory functional results achieved.**

Keywords: Complication, continence, cystectomy, enterocystoplasty.

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1. Introduction

Bladder tumors are the second most common urogenital cancer in men after prostate cancer [1]. Therapeutic management depends on the degree of infiltration of the detrusor by the tumor, as well as the presence or absence of lymph node and distant metastases [2], [3]. Several types of urinary diversion have been developed, but in recent decades external diversion has become less common than internal diversion, which is enterocystoplasty [4].

The principle of enterocystoplasty is to create a reservoir that closely reproduces the properties of a normal bladder, enabling the patient to live as normally as possible in terms of urination. This new reservoir is connected to the ureters and urethra to restore continuity to the urinary tract *et al*. low urine to flow without altering the body image.

The first enterocystoplasty dates back more than a century. In 1888, Tizzoni and Foggi published an orthotopic bladder replacement using an ileal segment in dogs. The first complete bladder replacement in humans was performed in 1951 by Couvelaire [5], and this enterocystoplasty was further perfected by Camey and Le Duc, leading to the first large series of cases in 1979 [6].

Since then, several other types of enterocystoplasty have been described, such as neovessels by GHONEIM,

GOLDWASSER, MAINTZ, etc. These procedures can be distinguished by the removed intestinal segment (ileal, ileocolic, or colonic), by the presence or absence of an anti-reflux system, and finally, by the type of ureteral reimplantation performed using either direct methods (NESBIT, WALLACE) or indirect anastomosis (such as mucosal groove, submucosal, seromuscular, or subserosal tunnel) [7].

In 1985, STUDER described a detubulated ileal neovessis combining the "cup-patch" technique described by GOODWIN in 1959 and the ileal ureter technique [8].

Nevertheless, despite the development of various techniques and the description of numerous studies, enterocystoplasty after radical cystectomy is still considered a major surgical procedure with a significant risk of morbidity and mortality [9].

1.1. Objective

The aim of the study is to evaluate the results in terms of functional results and morbidity of the Studer ileal neobladder performed in a single center.

2. Materials and Method

2.1. Patients and Population

This is a retrospective, observational, descriptive, monocentric, longitudinal study spanning 8 years from January 2015 to September 2022. It was compiled in the urology department of our hospital using a database of patients who underwent total cystectomy with Studer-type enterocystoplasty for bladder tumors.

The survey conducted using cluster sampling within our urology department enabled us to gather 26 patients diagnosed with an infiltrative bladder tumor. These patients had an indication for radical cystectomy and underwent Studer-type replacement enterocystoplasty as a means of urinary diversion.

Patients with a contraindication to bladder replacement were excluded from our study for the following reasons: Unmotivated patients or patients with reduced physical or intellectual capacity were excluded. Presence of renal insufficiency was identified by a plasma creatinine clearance <60 ml/min, calculated using the MDRD method. Indication of hepatic insufficiency was another exclusion criterion. Patients with chronic inflammatory bowel disease or a history of previous bowel resection were excluded. Exclusion criteria also encompassed invasion of the urethra and positive biopsies taken from there. Identification of lymph node or distant metastases led to exclusion. Additionally, those with limited life expectancy not improved by replacement itself and impairment of general condition with an ASA score >3 were excluded.

2.2. Study Procedure

All patients were informed preoperatively about their bladder tumor pathology, the various surgical options available, the advantages and disadvantages of each, any intraoperative limitations and potential changes to the procedure, the functional impact, and the quality of micturition.

During the diagnostic phase, all of our patients underwent renal and vesico-prostatic ultrasounds, a comprehensive biological work-up that encompassed a blood count, hemostasis assessment, blood grouping, fasting blood glucose analysis, blood ionogram evaluation, liver function tests, and a urine cytobacteriological examination (CBEU).

Subsequently, transurethral endoscopic resection of the bladder tumor (TURV) and pathological examination were conducted under the condition of a sterile. The pathology following transurethral resection revealed urothelial carcinoma in all cases. The anatomopathological results disclosed 18 tumors infiltrating the muscle (69.2%), classified as PT2, and eight superficial tumors (30.8%), classified as PT1. This included multiple tumors, large tumors that rendered endoscopic resection impossible, and tumors resistant to endovesical instillation. None of the urethral biopsies indicated invasion of the urethra by tumor cells.

The extension work-up comprised a thoracic-abdominal-pelvic CT scan, optionally including a bone scan if clinical signs of involvement were evident.

All patients received intravenous analgesia, which combined non-morphine analgesics and antispasmodics. This treatment commenced immediately postoperatively and was continued for an average duration of one week.

To mitigate the elevated thromboembolic risk linked to pelvic surgery, we administered heparin therapy to our patients. This therapy involved the use of 0.4 IU/Kg/day of subcutaneous Enoxaparin and was sustained for an average period of six weeks.

The average length of hospital stay for our patients was assessed, and a loopogram was systematically performed between days three and five to check for bag leaks. The neo-vesical catheter was removed around the 21st day, and an intravenous urography (IVU) was performed 48 hours after catheter removal, subsequent to checking renal function.

The initial follow-up visit occurred at the end of day 30, followed by subsequent visits on day 90, and then at intervals of 6, 12, 18, and 24 months, culminating in an annual frequency thereafter.

Biologically, a standard work-up was requested at each consultation, encompassing a complete blood count, a comprehensive blood ionogram, a CBEU, and measurement of urea and plasma creatinine.

Radiologically, along with the loopogram and IVUs, abdominal and pelvic CT scans were ordered at three, six, and 12 months. Additional examinations were indicated in specific situations based on clinical indications.

2.3. Immediate Postoperative Follow-Up

The following data was studied during the hospital stay: Immediate postoperative mortality; Getting up; Resumption of transit and feeding modalities; Removal of the drainage system; Condition of ureteral and neobladder tubes; Overall length of hospitalization; Daily care and hygiene of the neobladder in hospital.

2.4. Mortality

Intraoperative, early postoperative (before three months' follow-up), and late postoperative (after three months' follow-up) deaths were assessed.

2.5. Morbidity

We have classified the encountered complications according to whether they occurred early or late, that is, before or after three months following the operation.

Early postoperative complications included metabolic complications such as hydro-electrolytic disorders and acid-base disorders, as well as mechanical complications such as parietal infections, acute pyelonephritis, urinary retention due to mucous plugs, paralytic ileus, postoperative bleeding, and bag leaks.

Late postoperative complications included urethro-neobladder strictures, neobladder lithiasis, renal lithiasis, recurrent pyelonephritis, chronic metabolic acidosis and chronic renal failure.

2.6. Continence

Continence was assessed in 23 out of 26 patients at 12 and 24 months. It was also assessed by our unit during the follow-up visits. The severity of day- and night-time incontinence was scored by the patients using the Hautmann definition [10]: continence was defined as perfect when no pads were needed and the patient felt dry, satisfactory if maximum 1 pad was needed during the day or night, and unsatisfactory for others.

2.7. Data collection

Data were collected by the authors during the hospitalization and the pre- and postoperative visits. All patients were followed in our institution after surgery. Evaluation of urinary continence was made by a systematic patient interview conducted by the surgeon during the consultation.

3. Results

The average age of our patients was 60, with ages ranging from 44 to 76 years. All patients in our series were male.

3.1. Immediate Postoperative Follow-Up

No deaths occurred either intraoperatively or immediately postoperatively. The average duration of the surgical procedure was 300 minutes, ranging from a minimum of 280 minutes to a maximum of 360 minutes. The average blood loss was 600 mL, with a maximum of 1200 mL. Eight patients (30.7%) required intraoperative transfusion of two units of packed red blood cells. No organ damage or rectal wounds were observed intraoperatively.

We encouraged early mobilization for all our patients, starting within the first 24 hours after the operation. On average, bowel movements resumed on the 3rd day (+/−2). Patients resumed feeding around the 5th day after the return of bowel movements; in the meantime, they received a nutritious liquid diet.

The ureteral tubes were inserted intraoperatively, with the right tubes typically removed around day 11 and the left tubes around day 12. The neobladder catheter was removed approximately on the 15th day. Intravenous urography was systematically performed 48 hours after catheter removal to check for the presence of neovesico-ureteral reflux, which was not found in any of our patients.

We placed a Redon drain in the neobladder space in 20 patients (77%), and two drains in six patients (23%). The drains were typically removed at an average of day seven. The average length of hospital stay was 19 days, with extremes ranging from 16 to 25 days. The nasogastric tube was kept in place for an average of two days (1–4 days). It was retained until gas was released.

The neo-bladder was flushed every two hours for the first 24 hours, then every four hours on the second day, and subsequently every four hours at 48 hours post-op. Leak tightness was assessed using a loopogram performed systematically after the removal of the ureterostomy tubes and before the removal of the neobladder catheter. Only one bag leak was found.

3.2. Mortality

No intraoperative or early postoperative deaths occurred. However, one patient passed away 24 months after bladder replacement. This patient had been lost to follow-up, and the family reported death due to respiratory distress in the context of a deteriorating general condition, likely associated with tumor recurrence and pulmonary metastasis.

3.3. Morbidity

In regard to early complications, we observed 22 cases of hydro-electrolytic disorders, comprising four cases of dysnatremia, five cases of dyskalemia, five cases of dyscalcemia, five cases of dyschloremia, and three cases of hyperphosphoremia. Concerning acid-base disorders, we identified eight cases of metabolic acidosis and two cases of metabolic alkalosis. Additionally, 23 patients exhibited anemia, and one instance of early functional renal failure was identified. From a mechanical point of view, our series reported 10 cases of early complications in six of our patients. These included four cases of acute pyelonephritis, three instances of parietal infections, one case of urinary retention due to a mucous plug, one incidence of bag leak, and one case of paralytic ileus, amounting to a rate of 26.9%. Notably, there were no reported cases of postoperative bleeding, urinary fistula, or cardiovascular or thromboembolic complications.

Regarding late complications, we diagnosed 18 complications in 12 patients, constituting a rate of 46.1%. These included two cases of uretero-neobladder stenosis, two cases of neobladder lithiasis, one case of upper urinary tract lithiasis, eight cases of recurrent pyelonephritis, and five cases of chronic metabolic acidosis. Notably, there were no instances of ureteral stenosis, chronic renal failure, hernia, or eventration. Table I shows early and late postoperative complications observed in our case series.

3.4. Continence

On daytime continence, sixteen out of our 23 patients (69.5%) maintained continence after 12 months of follow-up, and this number increased to 21 (90%) at 24 months. The average number of daily micturitions was five, ranging from a minimum of four to a maximum of seven. After 12 months, 16 patients (69.5%) reported strict continence, while four (17.4%) were classified as grade 1 incontinent, two patients (8.7%) as grade 2 incontinent, and one patient

TABLE I: Early and Late Postoperative Complications Observed in our Case Series

Early complications	Number of observations	Percentage (%)	Late complications	Number of observations	Percentage (%)
Parietal infections and abscesses	3	11.5	Urethro-neobladder stenosis	2	7.7
Acute pyelonephritis	4	15.4	Neobladder lithiasis	2	7.7
Urinary retention due to mucous plugs	1	3.8	Urinary lithiasis	1	3.8
Occlusive syndrome in paralytic ileus	1	3.8	Recurrent pyelonephritis	8	30.7
Post-operative bleeding	0	0	Chronic metabolic acidosis	5	19.2
Bag leakage	1	3.8	Chronic renal failure	0	0
Lymphorrhoea-lymphorrhagia	0	0	Hernia-eventration	0	0
Urinary fistulas	0	0	Peritoneal effusion	0	0
Cardiovascular complications	0	0			
Total	10	26.9	Total	18	46.1

(4.3%) as grade 3 incontinent. No cases of hypercontinence were observed. By the 24-month mark, 21 patients (90%) declared strict continence, with only two (8.7%) classified as grade 1 incontinent. No instances of hypercontinence were observed.

Concerning nocturnal continence, at the 12-month follow-up, 15 out of our 23 patients (65.2%) were continent, and this number increased to 18 patients (81%) at the 24-month mark. The average number of nocturnal micturitions calculated was three, with a minimum of two and a maximum of four. At 12 months, 15 patients (65.2%) reported strict continence, four (17.4%) were classified as grade 1 incontinent, three patients (13%) as grade 2 incontinent, and one patient (4.3%) as grade 3 incontinent. No cases of hypercontinence were observed. By the 24-month mark, 18 patients (81%) had achieved strict continence, four patients (17.4%) were classified as grade 1 incontinent, and only one patient (4.3%) was categorized as grade 2 incontinent. No cases of hypercontinence were reported.

4. Discussion

The cystectomy is considered the gold standard treatment for infiltrative bladder tumors and superficial tumors with a high risk of recurrence. Although the long-term results of this treatment are still subject to debate, advances in intensive care anesthesia and surgical techniques appear to have improved the prognosis over the last two decades [11].

Presently, bladder replacement with an intestinal pouch is trending to become the most common form of diversion, as it offers a significantly higher quality of life compared to other diversions. This is achieved by respecting the patient's body shape and avoiding the necessity of wearing an external collector or self-catheterizing with a continuous urinary diversion such as the Bricker procedure [12].

The advantage of Studer's technique lies in a continental diversion technique that, thanks to ileal detubulation and a "U"-shaped layout, provides a low-pressure reservoir and sufficient neovesical capacity. Additionally, its simplicity and the ability to use short ureters contribute to its benefits [13].

Mortality, both intraoperative and postoperative, has significantly decreased over the years. This decline is closely associated with advancements in surgical techniques and anesthetic methods. Intraoperative mortality rates have plummeted from nearly 20% in the 1970s to less than 1% in the most recent publications. Our study has reported no intraoperative deaths, consistent with the findings in the literature [14], [15]. The rate of early post-operative mortality has also declined in recent decades, currently ranging between 1% and 4%. Our study did not document any instances of early postoperative deaths, aligning with the Italian study conducted by Maltagliati *et al*. [16], which similarly recorded no deaths within 90 days of surgery. However, some studies have documented instances of early deaths: 23 fatalities in the Hautmann *et al*.'s study [14] among 1000 patients over 22 years; four deaths in the Studer study [15], including three attributable to septic shock caused by Candida or Escherichia Coli, and one due to a stroke; two deaths in the Moroccan study at the Ibn Rochd University Hospital in Casablanca [17] resulting from pulmonary embolism and myocardial infarction; one death in the study by Gok *et al*. [18] following cardiovascular complications; and one death in the French study by Neuzillet *et al*. [19]. With regard to late post-operative mortality, the 5-year survival rate for enterocystoplasty is 77.2%, and the 10-year survival rate is 66% [20], [21]. Furthermore, the deaths observed in the majority of series studied are strongly linked to the progressive nature of the tumor disease and not to the surgical procedure. Table II shows the intraoperative, early and late mortality rates reported in some series of Studer-type bladder replacements.

Roughly 10% of patients who have undergone enterocystoplasty develop metabolic disorders that require therapeutic management [25]. The clinical progression of these disorders depends solely on the metabolic alteration, regardless of the type of urinary diversion. Symptoms vary based on each individual's compensatory capacity and the rate of onset of these issues [26]. Intestinal permeability to electrolytes enables the neovessia to absorb ions from urine, potentially resulting in hyperchloremic and hyperkalemic metabolic acidosis, which manifests as a

TABLE II: Intraoperative, Early and Late Mortality Rates Reported in Certain Series Concerning Bladder Replacement

Series	Country	Period	Number of patients	Mean age	Mean follow up (months)	Intraoperative mortality (%)	Early postoperative mortality (%)	Late postoperative mortality (%)
Hautmann *et al*. [14]	Germany	1986–2008	1013	62	3	0	2.3	–
Studer *et al*. [15]	Switzerland	1985–1997	200	64	30.2	0	2	50.5
Zhong *et al*. [22]	China	2007–2013	72	62	60	0	0	34.7
Maltagliati *et al*. [16]	Italy	2015–2017	18	–	24	0	0	5.55
Neuzillet *et al*. [19]	France	1990–2009	329	64	59.4	0.3	0.3	0
Gok *et al*. [18]	Turkish	2009–2018	98	60	25.1	1	1	20.4
Wyczolkowski *et al*. [23]	Poland	1998–2010	61	–	47.7	0	0	1.63
Chan *et al*. [24]	Canada	1995–2017	72	54	70	0	0	0
Our series	Morocco	2015–2022	26	60	24	0	0	3.84

'salt-loss syndrome' characterized by general malaise and dehydration [27], [28].

Several factors contribute to these disorders in ileal diversions [29]: intestinal absorption, where the primary risk is hyperchloremic metabolic acidosis; renal function; and changes in urine composition due to medications (such as phenylalanine, antibiotics, phenytoin, digoxin, theophylline, lithium, methotrexate, etc.). Recommendations include daily intake of alkaline water to prevent hydroelectrolyte imbalances, oral salt consumption to enhance sodium excretion and decrease electrolyte reabsorption, and immediate sodium bicarbonate supplementation post-surgery.

Our series reported 10 early complications in six of our patients (6/26), including 3 parietal infections (11.5%), four pyelonephritis (15.4%), urinary retention due to mucous plugging (3.8%), bag leakage (3.8%) and functional occlusive syndrome (3.8%), giving an early complication rate of 26.9%. This figure is similar to the results of the French study by Neuzillet *et al*. [19] who reported a rate of 27.2%. The study by Wyczolkowski *et al*. [23] reported a rate of 20.4%, mainly due to anastomotic loosening (25%) and digestive complications (50%). The series by Zhong *et al*. [22] reported a higher rate of 47.2%, with infectious causes being the most frequent complication (12.5%).

In terms of late complications, our study identified 15 complications in 12 patients, accounting for 46.1%. This percentage is similar to the findings of Studer *et al*. [15]. Who reported 47%. Various studies indicate that the most common complications include stenosis and recurrent pyelonephritis, followed by neobladder and upper urinary tract lithiasis, and hernias. Additionally, deterioration in renal function and chronic metabolic acidosis are frequently observed. Hydronephrosis primarily results from neovesico-ureteral reflux and the preoperative condition of the kidneys. The severity of acidosis is largely dependent on renal function. Table III shows the distribution of late complications in our series and a comparison with other publications.

Continence remains one of the most crucial and anticipated outcomes for patients following neovesical reconstruction [33]. Post-bladder replacement, there occurs a shift in mictional physiology and sphincter function. Micturition is no longer prompted by proprioceptive sensitivity; it is instead voluntarily initiated by a combination of hyperpressure and abdominal thrust (Valsalva maneuver). The objective of re-education is to establish vesico-sphincter neo-synergy, enabling sphincter relaxation and near-voluntary urine evacuation [34].

TABLE III: The Distribution of Late Complications in Our Series and a Comparison with Other Publications

Late complications	Our series	El Mahfoudi *et al*. [30]	Tilfine [31]	Zhong *et al*. [22]	Neuzillet *et al*. [19]	Wyczolkowski *et al*. [23]	Nam *et al*. [13]	Chan *et al*. [24]	Tanaka *et al*. [32]
Uretero-ileal strictures	0	0	5.2%	2.8%	6.9%	0%	0%	19.4%	0%
Urethro-neobladder stenosis	7.7%	0%	10.5%	18%	2%	8.7%	0%	1.4%	3.5%
Urinary lithiasis	3.8%	2.8%	0%	2.8%	0	0%	5.2%	11.1%	5.3%
Neobladder lithiasis	7.7%	0%	2.6%	4.2%	0	1.7%	0%	8.3%	7%
Recurrent pyelonephritis	30.7%	0%	0%	15.3%	0.3%	1.7%	26.3%	34.7%	1.8%
Inguinal hernia	0%	5.8%	2.6%	4.2%	0%	0%	0%	0%	12.3%
Chronic renal failure	0%	2.8%	5.2%	–	4.3%	1.7%	31.5%	36.1%	0%
Chronic metabolic acidosis	19.2%	0%	0%	–	15%	–	0%	13.9%	15.8%
Postoperative complications rate	46.1%	14.2%	23%	58.3%	20.4%	14%	23.1%	23.1%	54.38%

TABLE IV: The Results of Various Studies on Continence in Relation to Our Study

Series	Number of patients	Daily continence (%)	Nocturnal continence (%)
Studer *et al*. [15]	200	92	84
Hautmann *et al*. [14]	363	96	95
Neuzillet *et al*. [19]	321	92	87
Joniau *et al*. [37]	58	95	66
Soulié *et al*. [38]	55	89	79
Hollowell *et al*. [39]	50	93	86
Arai *et al*. [40]	66	95	67
Nieuwenhuijzen *et al*. [41]	62	90	67
Cancrini *et al*. [42]	96	97	83
Meyer *et al*. [43]	104	98	96
Abol-Enein *et al*. [44]	450	93	80
Koie *et al*. [45]	96	91.6	10.5
Jensen *et al*. [46]	67	90	65
Our series	26	90	81

Several factors influence continence outcomes following cystoplasty [35]: absence of intraoperative sphincter trauma, preservation of adequate functional urethral length, avoidance of bladder outlet folding that could elevate the risk of retention and urinary infection, the specific segment of bowel utilized, reservoir shape, and the functional capacity of the neobladder.

The results obtained in our series align positively with those documented in the literature. Studer's technique represents a continent diversion approach that, through ileal detubulation and a "U" configuration, facilitates achieving a low-pressure reservoir and sufficient neobladder capacity. In addition to the surgical technique, other measures are recommended for preventing and treating incontinence [36]:

- ✓ Maintain a low post-micturition residual: educate the patient about proper micturition, teach self-catheterization at home, treat hernias and urethro-neobladder strictures if present, etc.,
- ✓ Treat urinary tract infections,
- ✓ Establish a voiding schedule,
- ✓ Educate the patient on achieving proper bladder emptying,
- ✓ Practice abdominal contractions,
- ✓ Furthermore, to address nocturnal incontinence, it is advisable to avoid consuming alcohol, diuretics, or hypnotics.

Table IV shows the results of various studies on continence in relation to our study.

5. Conclusion

Enterocystoplasty is now the preferred diversion method following total cystectomy, replacing the Bricker-type external urinary diversion. Bladder replacement techniques have been extensively performed and documented in the literature, yielding favorable long-term outcomes. However, patients undergoing this procedure must be capable of adapting to the neo-bladder post-operation and remain vigilant regarding potential complications.

It is plausible that a neo-bladder may never fully replicate the functionality of the patient's original healthy bladder. Consequently, not all patients may fully regain their pre-operative functional state, leading to potential issues with incontinence and an overall decline in quality of life.

Nonetheless, enterocystoplasty remains a crucial procedure that continues to evolve, showcasing enhancements in both oncological control and patients' functional well-being. The satisfactory functional outcomes from our research suggest that Studer's technique stands as one of the most optimal methods for urinary diversion in terms of surgical efficacy.

Abbreviations

CBEU	Urine cytobacteriological examination
CT	Computer tomography
IU	International unit
KG	Kilogram
IVU	Intravenous urography

Conflict of Interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

Availability of Data and Materials

The data of and materials used in the present study will be provided on request via the corresponding author.

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