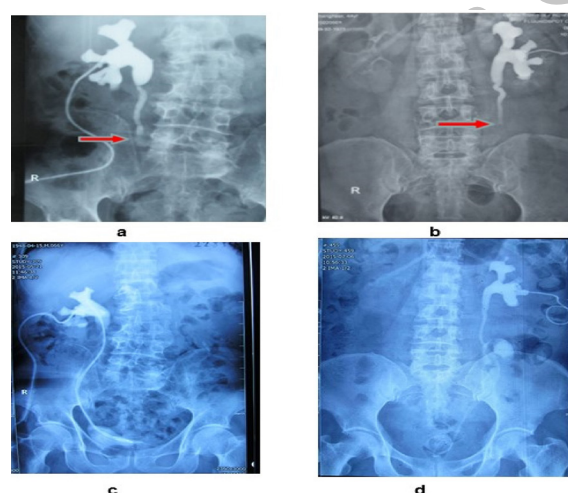


## Yang-Monti Principle in Bridging Long Ureteral Defects: Cases Report and A Systemic Review

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**Keywords:** reconstruction; ileal ureteral replacement; long ureteral defect; Yang-Monti Principle.

Ureteric substitution using the Yang-Monti principle was reported as a modification of simple ileal ureter replacement. During April 2013 to June in 2015, 2 patients underwent ileal ureteral substitution using a reconfigured ileal segment of Yang Monti principle in our clinical center. Some slight modifications were made and then follow-up were carried out up to 12 months. For these 2 cases, no significant intra/post-operative complications occurred. In 1 year follow up, serum creatinine (Scr) and blood urea nitrogen (BUN) of both patients decreased to normal. Glomerular filtration rate (GFR), renogram and pyelogram showed a stable split renal function. To better understand the Yang-Monti principle and potential risks and complications, we conduct an systemic review by searching PubMed, Google Scholar and the Cochrane Library database from January 1996 through June 2016. 10 out of 644 publications were identified, which included 269 patients from cohort studies. The most usual indications for Yang-monti therapy were iatrogenic stricture and retroperitoneal fibrosis. Infection and ileus were indicated as the main short time postoperative complications while the fistula and re-strictures happened in long-term. In general, we believe Yang-Monti Principle is a safer and efficient technique for clinical partial and complete ureteral defects if patients and potential risks could be well prepared.



**Figure1:** Antegrade angiography images preoperative and post-operative **a.**pre-op (M) **b.**pre-op (F) **c.**post-op (M) **d.**post-op (F).

## INTRODUCTION

Ureteral loss represents a surgical challenge to provide low pressure drainage while avoiding urinary stasis and reflux. The ideal replacement should optimize drainage while minimizing absorption, allowing for ureteral repair of varied lengths and locations with maximal preservation of the urinary tract. Long-segment ureter defects usually appeared in surgery of severe ureteric obstruction or ureteric stricture, which might be caused by neoplasms, retroperitoneal fibrosis, iatrogenic injuries during open or endourological surgeries, radiation/chemical damage and chronic inflammation.

Various techniques have been described in literature to handle such problems posed by a shortened ureter not amenable to repair by direct re-anastomosis. One modifications is the application of Yang-Monti principle which allows the creation of a long tube from short bowel segment after its re-configuration.

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**Table 1.** The basic information of two cases

	Case 1	Case 2
Gender	Male	Female
Age	75	41
Etiology	Urothelium carcinoma of solitary kidney	Iatrogenic stricture
Locations of defect	Right Mid-ureter	Left upper-ureter
Length of defect (cm)	22	15
Surgery time(min)	384	302
Hospitalization(d)	23	15
Antibody time(d)	11	7
D-J tube removal(w)	4	6

**Abbreviation:** cm: centimeters, min:minutes, d:days, w:weeks

First coined in 1996 to describe using small bowel for ureteric replacement got widely acceptance, which was applied for ureteral replacement first in dogs<sup>(1)</sup> then clinically<sup>(2)</sup> in few case reports. The feasibility of constructing a long tube from short segments of ileum was evaluated clinically<sup>(3,4)</sup> and experimentally<sup>(5)</sup>. Due to the excellent functional outcome, the technique was applied in the clinical setting. However, potential postoperative risk of urine leakage, peritonitis and urine reflux occur occasionally, which need to take into account. Moreover, experiences of Yang-Monti in China/Asia remain rare. We believe some paucity of modification could facilitate and thus report our experiences on 2 patients in our center. Moreover, we performed a systemic review on the outcome, risks and complications of surgery.

## REPORT OF CASES

Two cases were performed during April 2013 to June

in 2015 in our clinical center. Both patients underwent preoperative evaluation in the form of careful history taking, medical examination and laboratory investigations which included complete routine blood tests, urine analysis, blood renal function, coagulation function, sodium, potassium, and chloride estimation (**Tables 1 and 2**). Radiological investigations to visualize the upper urinary tract included renal ultrasonography, intravenous urography (IVU) or computerized tomographic urography (CTU). Glomerular Filtration Rate (GFR) / renal isotope scanning (RIS) were performed to estimate the split renal function. All patients underwent preoperative colonic preparation for 24 hours. The study was approved by the ethical committee of Second Hospital of Lanzhou University (2015A-078). Both patients were consented for approval of surgery.

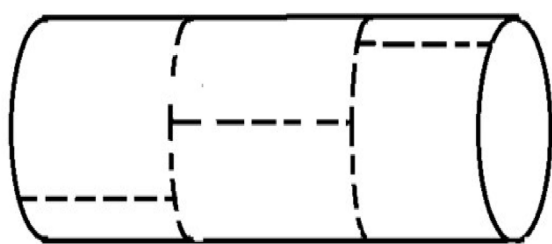
### Case 1: 75 year-old male

A 75 year-old man presented to us with a chief com-

**Table 2:** Basic Laboratory Findings of Two Cases

	Case 1: Ureteral Carcinoma (M)		Case 2: Ureteral Obstruction (F)	
	Pre-op	Post-op	Pre-op	Post-op
WBC (×10 <sup>9</sup> /L)	8.7	4.32	6.86	7.33
HGB (g/L)	127	106	140	126
HCT (L/L)	0.387	0.335	0.420	0.388
U-RBC (/uL)	3722.5	10-20/HPF	37.4	1-3/HPF
U-WBC (/uL)	301.5	0-2/HPF	1295.3	0-2/HPF
PH (-)	6.5	6.5	6.5	6.0
BUN	84	4.7	6.0	12.3
Scr	1200	67	68	86
Sodium	143.6	138.7	141.7	147.8
Potassium	3.5	3.86	3.9	4.33
Chloride 104.2	112.2	102.5	115.0	

**Abbreviations:** pre-op: preoperative examination, post-op: postoperative examination, WBC: white blood cell, HGB: hemoglobin, HCT: hematocrit, SRF: serum renal function, Scr: serum creatinine,



**Figure2:** The malposed suture of ileal segments ----- suturing line

plaints of for intermittent hematuria lasting for 5-6 weeks and anuria for 1 week. He also had a history of left nephrectomy 10 years ago. On admission, no comorbidities were found, personal and family histories were negative for previous cancers. A high level of Scr (1200 $\mu$ mol/L) was observed (**Table 2**) and the non-contrast enhanced CTU images delineated an upper right dilated ureter. Right nephrostomy was performed to decrease the creatinine. Antegrade imaging via nephrostomy tube demonstrated ureter obstruction located in the level of the anterior superior iliac spine. (**Figure 1**) We thus performed ureterscopic biopsy and pathology showed low-grade urothelium carcinoma. With these findings, a diagnosis of urothelium carcinoma was made. The patient strongly claimed for treatment. Con-

sidering his solitary kidney, after all palliative therapy options discussed, we offered the patient two surgery choices: 1. keeping nephrostomy tube after radical ureteral resection and surveillance; 2. ileal ureteral substitution after radical ureteral resection and surveillance. The patient finally decided to choose the latter option.

#### **Case 2: 41 year-old female patient**

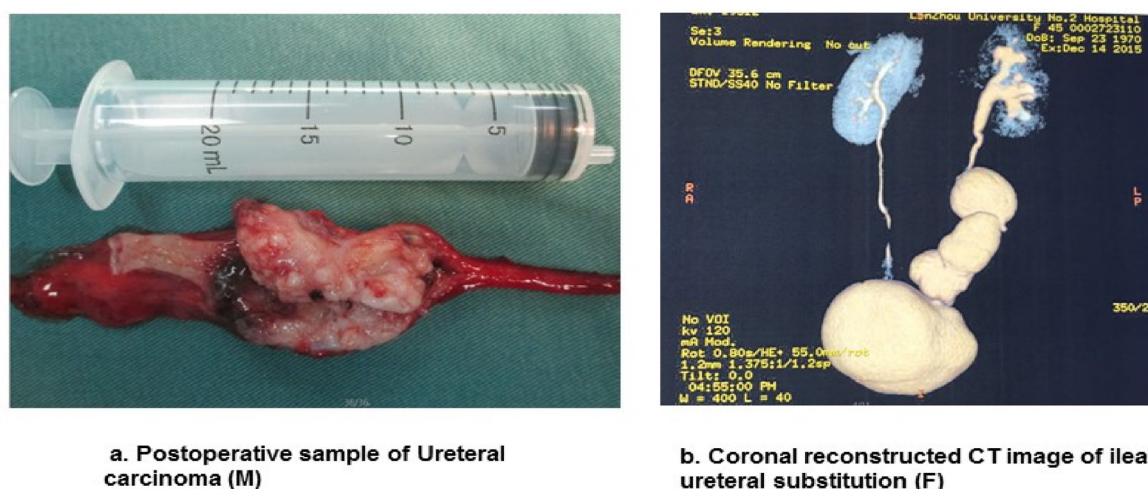
The other case was a 41 year-old female patient referred for left flank pain and intermittent fever. She had history of ureteroscopy and lithotripsy for left proximal ureteral calculus and bladder-musculature flap surgery due to ureteral stricture 1 year before admission. On admission, laboratory findings were normal (**Table 2**). The non-contrast enhanced CT scan, nephrostomy, antegrade imaging and cystoscopy were performed in sequence. The results confirmed left proximal upper tract ureteral obstruction, combined with hydronephrosis. The left ureteric orifice was not detected in cystoscopic examination. All treatment options were discussed, however, we had no choice but to perform ileal ureteral substitution surgery of Yang-Monti principle owing to a 15 cm ureter defects of bladder-musculature flap surgery history. (**Figure 1**)

Surgery technique was basically according to with previous Yang-Monti principle demonstration<sup>(6)</sup>. The differences existed in anastomosis. We used malposed suture method and a non-refluxing Lich-Gregoir technique to reduce the risk of re-stricture and calculus formation. Malposed suture method focused on non-direct

**Table 3:** Follow-up information of Two Cases

	3m follow-up	6m follow-up	12m follow-up
<b>Case 1: UC (M)</b>			
WBC ( $\times 10^9/L$ )	3.97	5.25	9.18
HGB (g/L)	108	110	92
HCT(L/L)	0.340	0.365	0.378
U-RBC (/uL)	75.7	1-3/HPF	0-2/HPF
U-WBC (/uL)	23.7	0-2/HPF	0-1/HPF
PH (-)	6.5	6.5	6.5
BUN	5.7	6.3	4.8
Scr	170	121	146
<b>Case 2: US (F)</b>			
WBC ( $\times 10^9/L$ )	7.14	6.56	4.23
HGB (g/L)	128	122	118
HCT(L/L)	0.396	0.412	0.384
U-RBC (/uL)	16.4	0/HPF	0/HPF
U-WBC (/uL)	28.2	0-1/HPF	0-1/HPF
PH (-)	6.0	6.5	6.5
BUN	4.6	6.3	5.1
Scr	87	75	78
GFR(ml/min)	-	L: 24.9, R: 61.1	L: 26.6, R: 73.1

**Abbreviations:** uc: Ureteral Carcinoma, US: Ureteral Stricture, pre-op: preoperative examination, post-op: postoperative examination, m: months, WBC: white blood cell, HGB: hemoglobin, HCT: hematocrit, SRF: serum renal function, Scr: serum creatinine, GFR: Glomerular filtration rate



**Figure 3:** Samples(M) and reconstruction CT(F) of patients.

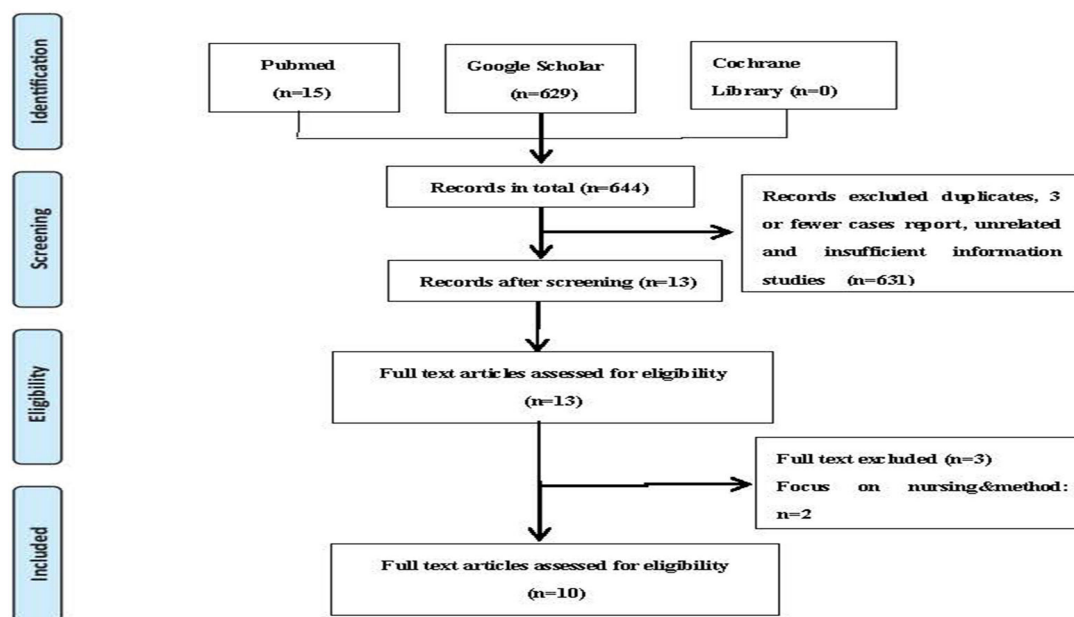
suture line forming “T-shaped” anastomotic stomas which generate less suture corners compared to “cross-shaped” stomas of traditional suture method and decrease the potential risks of urine leakage from suture corners, which might be of benefit for urine leakage prevention. (Figure 2) At the end of the procedure, nephrostomy tube, double-J stent, drainage tube for ret-

roperitoneal cavity and urethral catheter were inserted. Postoperative fluid infusion and intermittent bladder washing were carried out for 2 weeks. Drainage tubes were removed 2-3 days after operation and double J tube were maintained for 4-6 wks. Antegrade imaging was performed at 4 weeks after operation which revealed fluent drainage of ileal ureteral substitutions.

**Table 4:** Studies Characteristics of Yang-monti principle and ileal ureteral reconstruction (1996-2016)

Author (years)	Country	Type	N	Mean Age (Y.O)	Followup patients: time	Post-op complications	Long-term (> 3m) complications	Evidence level
Ali-el-Dein B(2003) <sup>3</sup>	Egypt	cohort	10	48.7	10/10: 12m	Urinary leakage Urinary tract infection: 4/10	Reflux: 1/10	2c
B I.Chung(2006) <sup>11</sup>	UK	CC & cohort	52	48.6	52/52: 72m	Pyelonephritis: 4/52 Wound infection: 1/16	Reflux Failure: 3/52 Stricture: 2/16	2b
SA. Armatys(2008) <sup>10</sup>	US	cohort	91	46.8	91/91: 36m	Infection: 23/91 Bowel Obstruction: 15/91	Fistula: 9/91 Stricture: 7/91	2b
Steffens JA(2010) <sup>15</sup>	German	cohort	18	47.4	18/18: 50m	Infection and paralytic ileus: 9/18	Infections & Fistula: 4/18	2b
M.Esmat(2013) <sup>6</sup>	Egypt	cohort	16	35.0 ± 8.0	9/16: 44m	Urinary leakage: 1/16 Infection: 4/16	None	2b
Ordorica R(2014) <sup>13</sup>	U.s	cohort	16	45	16/16: 44m	None	Ureteral Fistula: 1/16 Bilateral Obstruction: 1/16	2b
M.Takeuchi(2014) <sup>16</sup>	Japan	cohort	8	43.6	8/8: 60m	Metabolic acidosis: 3/8	Fistula: 2/8 Stricture: 1/8	2c
S.S Nazir(2015) <sup>14</sup>	India	cohort	9	35.0	9/9: 36m	Urinary leakage: 1/9 Wound infection: 1/9	None	2c
YM Xu(2015) <sup>9</sup>	China	cohort	44	41.0	43/44: 69m	Intestinal Obstruction: 2/43	None	2c
Maigaard(2015) <sup>7</sup>	Danmark	cohort	5	47	5/5: 41m	Urinary leakage: 3/5	Ureter Stricture: 1/5	2b

**Abbreviation:** Cc: Case-Control; YO: Years Old; Post-op: Post Operation; m: month



**Figure 4:** Flow Chart of Studies and patients search strategy

The hydronephrosis severity of the first case was greatly improved. Nephrostomy tubes were removed under the evidences of no fever or flank pain observed after tube clamping. (Figures 1 and 3)

We appointed three follow up visits at 3, 6 and 12 months after operation to evaluate the recovery of these patients. Blood routine tests, urine analysis, blood renal function, IVU and GFR test were thus performed. The male patient refused to take radioactive tests while the female patient accepted all after informed consent.

During follow-up, no urine leakage, obstruction, excess mucus production, metabolic abnormalities, frequency, oliguria or odynuria were observed. IVU revealed fluently drainage in both patients 3 month after operation. The differential GFR of the female patient for left and right kidneys were 24.9ml/min and 61.1 ml/min on 6-month follow up and promoted to 26.6ml/min(left) and,73.1ml/min(right) on 12-month follow up. (Table 3).

## SYSTEMIC REVIEW

### Search strategy of systemic review

For systemic review, we used the PICOS method according to the PRISMA statement (CRD42015019212; <http://www.crd.york.ac.uk/PROSPERO>). A search for articles published from January 1996 through June 2016 using 3 databases, PubMed, Google Scholar, and the Cochrane Library database was conducted for potentially eligible studies using a reproducible strategy. The search was limited to 20 years because the Yang-monti principle firstly applied in dogs starting in 1996. The following separate searches were conducted using medical subject heading (MeSH) terms to maximize the search results. The search resulted in 644 citations. Duplicates and experts reviews were removed. The laparoscopic/robotic surgery, pediatrics and few cases report (cases less than 3) were excluded. Studies with inconsistent/insufficient data or errors, conferences abstract and unpublished reports were also excluded.

### Studies selection

A total of 644 potential relevant abstracts in MEDLINE (n = 15), Google scholar (n = 629), the Cochrane Library (n = 0) were examined. 631 were duplicates, unrelated, 1-3 cases report, pediatrics or not original articles; two papers<sup>(7,8)</sup> did not mainly focus on Yang-Monti principle and postoperative complications, one<sup>(9)</sup> probably involved the same patients. The remaining 10 publications<sup>(10)</sup> published during 2003-2015 were included in our systemic reviews. (Figure 4)

### Studies Characteristics

A total of 269 patients were recruited across all 10 cohort studies. Considering the different states of patients and medical levels, etc. might generate the high heterogeneity, we just demonstrated the clear information extracted from publications and the vague information was excluded. Among all 269 cases, 9.67% (26/269) were from Africa, 27.8%(75/269) were from Europe, 22.68%(61/269) were from Asia and 39.78%(107/269) were from the U.S. The most usual indication for operation was iatrogenic stricture (approximate 51.46% □123/239) and then retroperitoneal fibrosis (approximate 16.73%, 40/239) (data not shown). Regularly, the antibodies were performed 1-2 weeks and DJ tubes were dilated for 2-5 weeks. The short time postoperative complications were infections (27.9%, 75/269) and ileus (9.6%, 26/269). Fistula (4.7%, 12/251) and strictures (4.1%,11/269) were more probably to appear after 3 months(Table 4). The approximate percentages we used were not accurate but close to the result of larger sample research<sup>(8,9)</sup> when we performed analysis respectively.

## DISCUSSION

In 1993, Yang was the first to describe two small previously detubularized ileal segments to develop transverse tube in a patient undergoing radical cystectomy. The patient remained continent and had no difficulties



with catheterization. Unfortunately, the main topic of publication focused on the investigator's creation of an antireflux mechanism needle on the ileal wall but not the construction technique. There was no reference to the conception of the new tube in the title or abstract of the publication. Perhaps this was the reason why the technique continued to be unknown until 1997, when Monti et al. described independently the detailed construction of single and double ileal tubes in dogs<sup>(1)</sup>. Yang Monti technique was thus widely recognized and accepted. Other following reports presented different bowel segments (intestinal or colon) for ureteric replacement. The merits of the ileal segment are its mobility, small diameter, and constant blood supply. However, common postoperative risks were urine leakage, peritonitis, colic, strictures and infections<sup>(11,12)</sup>. In addition, drawbacks mostly attributed to the absorbing and secreting characteristics of the involved bowel segments such as hyperchloremic metabolic acidosis and excess mucus production and also to the wide caliber refluxing ileal ureter with subsequent progressive dilatation, functional obstruction and recurrent UTI<sup>(13,14)</sup>. In our two cases, we made slight modifications<sup>(1)</sup>. We located ureteric replacement in the retroperitoneum, which is more accordant to the initial physiological characteristics and can decrease the interference in abdomen. In addition, urine leakage or localized infections associated with postoperative complications might be much easier to drain out due to cavity space limitation, which would notably decrease peritonitis, strictures and infections and benefit for ERAS (Enhanced Recovery After Surgery)<sup>(2)</sup>. We used a non-antireflux mechanism in the distal end-to-end anastomosis between bladder and ureter. Lich-Gregoir methods also generate strictures<sup>(15,16)</sup>, the patients with calculus and stricture history might be better without antireflux mechanism. In these two cases, direct anastomosis made our surgery more simple and less time consuming, and also could significantly reduce the ureteric ileal segment replacement and ureteral path. The less secretion of succus entericus might be of benefit for maintaining the normal function, efficient urine drainage and fast recovery of the newly reconstructed urinary tracts<sup>(3)</sup>. The malposed suture method was employed in the ileal segments for end-to-end anastomosis in these two cases, which might be efficient to decrease the occurrence of urine leakage after operation. However, this procedure needs more evidence.

During follow-up, no complaint of stricture, fistula, excess mucus production was observed by others<sup>(17,18)</sup>. These might be an advantage of slight modifications and most probably due to the marked reduction in the size of the secreting surface area in comparison with simple ileal ureters that may be associated with mucous obstruction in some cases. In addition, hyperchloremic metabolic acidosis was not observed, which was reported in varying percentages by some studies<sup>(14)</sup>. Absence of metabolic disorders among our cases might have contributed to proper surgery timing selecting (serum creatinine  $\leq 100$  mmol/L), reduction of the size of absorbing surface area might decrease the contact of urine with the ileal mucosa.

Our systemic review, to our knowledge, is the most comprehensive review on the topic at present. We had to admit that systemic review of these no-control and cohort prospective/retrospective studies might have

high heterogeneity due to limited cases, different etiologies and similar outcomes in literature, which would generate multiple potential biases. Therefore, extracted data of these ten publications did not fit for a meta-analysis. We just presented the publications to show clear and brief information. We suppose some preventive measures could be taken into account to prevent some potential complications, i.e. maintaining temporary urinary diversion through preoperative nephrostomy tube, postponing removal of double-J tube to 12-24 weeks, maintaining great blood supply of ileal segments in surgery and proper antibiotics, which might efficiently reduce the possible occurrence of short-term infection, ileus and leakage after surgery as well as fistula and stricture in a long run.

Nevertheless, although our two patients had different clinical courses and we were convinced that we provided them with optimal treatment at that time, long-term follow-up and more cases are needed, particularly in the evaluation of non-antiflux influence in certain patients with similar clinical causes. We believe that widespread of the kind of Yang-Monti principle is necessary and should be performed in caution. Our work might be helpful to some urologists who identify or develop new modification surgery setting and can benefit appropriate patients.

## CONCLUSIONS

In general, we believe Yang-Monti Principle is a safer and efficient technique for clinical partial and complete ureteral defects if patients and potential risks could be well prepared. Our cases experiences and review findings might be helpful to some urologists and may benefit proper patients. Multi-center experiences and long-term follow-up remain necessary in future.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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