



Original Research

Double J stent is superior to externally draining ureteric stent in enhancing recovery after kidney transplantation – A prospective cohort study

Moira H.D. Bruintjes^{a,b,*}, Johan F. Langenhuijsen^b, Anneke Kusters^c, Luuk B. Hilbrands^d, Frank C.H. d'Ancona^{b,1}, Michiel C. Warlé^{a,1}

^a Department of Surgery, Radboud University Medical Center Nijmegen, the Netherlands

^b Department of Urology, Radboud University Medical Center Nijmegen, the Netherlands

^c Department of Urology, Queen Beatrix Regional Hospital Winterswijk, the Netherlands

^d Department of Nephrology, Radboud University Medical Center Nijmegen, the Netherlands

ARTICLE INFO

Keywords:

Kidney transplantation
Postoperative recovery
Double J stent
Percutaneous stent
Length of hospital stay

ABSTRACT

Background: Routine intraoperative ureteric stenting lowers the rate of urological complications after kidney transplantation. However, there is no consensus about the optimal stent design and duration. The aim of this prospective cohort study was to compare the influence of double J (JJ) stents and externally draining percutaneous (PC) stents on the early quality of recovery after living donor kidney transplantation.

Materials and methods: A prospective cohort study was performed in two consecutive cohorts of 40 patients who underwent living donor kidney transplantation at the Radboud university medical center between April 2016 and October 2017. The first cohort of 40 patients received a 6-French externally draining PC stent. The second cohort of 40 patients received a 6-French/14 cm JJ stent. We compared the influence of the stent design on the quality of early post-operative recovery (measured by the Quality of Recovery-40 questionnaire) and the length of hospital stay.

Results: Patients with a JJ stent scored significantly better on the Quality of Recovery score on the third and fifth postoperative day, when compared to patients with a PC stent. Furthermore, in comparison to patients with a PC stent, patients with a JJ stent were earlier mobilising and independent in daily activities, resulting in a shorter length of hospital stay. The number of postoperative urological complications was comparable between the two groups.

Conclusion: The use of JJ stents during living donor kidney transplantations improves the postoperative recovery and shortens the length of hospital stay, when compared to PC stents without compromising the number of postoperative urological complications.

1. Introduction

The two major urological complications (MUCs) after renal transplantation are urinary leakage and ureteral obstruction, mostly located at the ureterovesical junction or in the distal transplant ureter [1]. These complications contribute to patient morbidity, graft loss and mortality. It has been demonstrated that routine intraoperative ureteric stenting leads to a significantly lower urological complication rate [1,2]. However, there is no consensus about the optimal stent type and duration of ureteric stenting. The most commonly used stent types include internal double-J (JJ) stents and externally draining percutaneous

(PC) stents. A small number of retrospective studies compared the outcomes of JJ stent *versus* PC stent placement in renal transplantation [3–6]. All these studies support the use of a JJ stent, in terms of decreased urological complications, when compared to PC stents. None of these studies revealed a significant difference between the two groups in the number of urinary tract infections (UTI). Reported duration until stent removal varies from two weeks to three months. Several meta-analyses have been performed concerning the optimal timing of JJ stent removal following renal transplantation [7–9]. The overall conclusion of these studies was that a period of 2 weeks could be a reasonable timing for stent removal, since this offers enough time for proper

* Corresponding author. Department of Surgery, Radboud University Medical Center Nijmegen, the Netherlands.

E-mail addresses: Moira.Bruintjes@radboudumc.nl (M.H.D. Bruintjes), Hans.Langenhuijsen@radboudumc.nl (J.F. Langenhuijsen), a.kusters@skbwinterswijk.nl (A. Kusters), Luuk.Hilbrands@radboudumc.nl (L.B. Hilbrands), Frank.dAncona@radboudumc.nl (F.C.H. d'Ancona), Michiel.Warle@radboudumc.nl (M.C. Warlé).

¹ Both authors contributed equally to this work.

<https://doi.org/10.1016/j.ijisu.2019.09.031>

Received 17 August 2019; Received in revised form 15 September 2019; Accepted 27 September 2019

Available online 07 October 2019

1743-9191/ © 2019 IJS Publishing Group Ltd. Published by Elsevier Ltd. All rights reserved.

healing of the anastomosis, without increased risks of UTI or other stent-related complications. At the Radboudumc, approximately 100 living donor kidney transplantations are performed annually. The standard protocol includes intraoperative placement of an externally draining PC stent. The main reason for the choice of this stent design is the ease of monitoring the excretory function of the graft. A second reason is the simplicity of the stent removal. According to the protocol, the PC stent is removed at postoperative day five (or day seven in patients with diabetes mellitus), followed by removal of the transurethral catheter two days later at postoperative day seven (or day nine in patients with diabetes mellitus) in order to spontaneously close the bladder. Consequently, the minimum duration of hospital stay after kidney transplantation at our centre is seven days after surgery. Enhanced recovery after surgery (ERAS) protocols have gained widespread recognition in general surgery, decreasing the length of hospital stay while maintaining equivalent or lower morbidity and increased patient satisfaction [10,11]. The use of JJ stents might help to improve the early quality recovery after living donor kidney transplantation as this avoids an external PC stent and prolonged use of a bladder catheter. The aim of this prospective cohort study was to compare the influence of JJ stents and externally draining PC stents on the early quality of recovery after living donor kidney transplantation.

2. Patients and methods

2.1. Patients

All patients (≥ 18 years) who were scheduled for a living donor kidney transplantation, between April 2016 and October 2017 at the Radboudumc, were screened for inclusion and were approached at least two weeks before surgery. Patients were included after obtaining oral and written informed consent, unless they met one of the exclusion criteria: insufficient control of the Dutch language to read the patient information and to fill out the questionnaires; patients undergoing a retransplantation in the same iliac fossa; patients with ileal conduits or continent urinary diversions; patients with an abnormal lower urinary tract; patients with a pain syndrome or psychiatric history; chronic use of analgesics or psychotropic drugs; patients with a pre-operative Quality of Recovery score below 150 (see outcome measures); patients in whom narcosis is necessary for cystoscopy (JJ cohort only); patients with intra-operative difficulties with the vascular anastomoses or a high ureteral anastomosis with need for conversion to an externally draining PC stent (JJ cohort only); patients with primary focal segmental glomerulosclerosis (FSGS) requiring postoperative proteinuria screening (JJ cohort only).

The trial was approved by the local ethics committee, the Central Committee on Research involving Human Subjects, Arnhem-Nijmegen, The Netherlands, reference number 2016–2426 (Chairperson R.B. Keus) on 6 April 2016. The trial was registered at researchregistry.com (ID: researchregistry5073). The work has been reported in line with the STROCSS criteria [12].

2.2. Study design

We performed a prospective cohort study in two consecutive patient cohorts. The first cohort of 40 patients received a 6-French externally draining PC stent, in accordance with the standard protocol at the Radboudumc. The second cohort of 40 patients received a 6-French/14 cm JJ stent.

2.3. Procedure

Baseline data were collected at time of inclusion, i.e. the day before surgery. Preoperatively, all patients received 2000 mg ceftriaxone as antibiotic prophylaxis (or 960 mg co-trimoxazole in case of allergy for ceftriaxone) and 100 mg prednisolone. All renal transplantations were

performed by a fixed experienced surgical team, consisting of a vascular surgeon and a urologist. In all patients, the ureterovesical anastomosis was performed according to the extravesical Lich-Gregoir technique. At the end of the procedure a surgical drain was placed in the transplanted iliac fossa. Peroperative data were extracted from the electronic medical record system, including duration of surgery, total ischaemia time, and vascular anatomy and peroperative complications.

In the PC cohort, the PC stent was removed after five days (or seven days in patients with diabetes mellitus), followed by removal of the transurethral catheter at postoperative day seven (or day nine in patients with diabetes mellitus). In the JJ cohort, the transurethral catheter was removed after five days (or seven days in patients with diabetes mellitus), and the JJ stent after two to three weeks at the outpatient clinic by cystoscopy. The surgical drain was removed in both cohorts when the production was less than 100 ml per day. Before discharge (and after removal of the urethral catheter) an abdominal ultrasound was performed in all patients to screen for postoperative lymphoceles, hydronephrosis, urinomas, perfusion defects, or bladder retention. Only symptomatic lymphoceles were treated by drainage.

Standard immunosuppression therapy consisted of basiliximab, tacrolimus, prednisone and mycophenolate mofetil (MMF) and was given to all recipients. Postoperative pain management consisted of paracetamol (1000 mg every 6 h) and intravenous patient-controlled analgesia with piritramide. When possible, patient-controlled analgesia was replaced by oral analgesics (oxycodone). All patients were treated postoperatively with co-trimoxazole for prophylaxis of *Pneumocystis jirovecii* pneumonia.

2.4. Outcome measures

During their hospital stay, participants were daily monitored by the research physician until the day of discharge. The primary outcome measure was the Quality of Recovery-40 (QoR-40) score. The Quality of Recovery-40 is a validated patient-rated questionnaire with a maximum score of 200, measuring five dimensions of recovery after surgery including comfort, emotions, physical independence, pain, and patient support [13]. The day before surgery, the questionnaire was explained to the participant and a baseline measurement was performed. In case the preoperative QoR-40 score was $< 150/200$ points, the patient was excluded.

Secondary outcomes were the intervals between transplantation and removal of the surgical drain, the transurethral catheter and the ureteric stent, and performance of the ultrasound. Serum creatinine levels were recorded daily during hospital stay. Achievement of classic surgical discharge criteria was daily registered (including adequate pain control with oral medication, passage of flatus or defaecation, tolerance for solid food intake, mobilisation at the ward, and independence in daily activities). Patients who achieved all the classic discharge criteria could be discharged when they met the following additional discharge criteria: transurethral catheter removed, stable graft function, sufficient patient control over the use of immunosuppressive drugs, and an abdominal ultrasound being performed. Graft function was considered not stable when the serum creatinine level had increased more than 20% from the lowest value. Furthermore we registered cumulative use of morphine equivalents; and complications, graded according to the Clavien-Dindo classification [14,15].

Follow up was performed 14 days after surgery and included the QoR-questionnaire, postoperative complications, and the International Consultation on Incontinence Questionnaire - Lower Urinary Tract Symptoms (ICIQ-LUTS) [16]. Patients in the JJ cohort were also asked how they experienced the cystoscopy for JJ stent removal.

2.5. Sample size calculation and data analysis

Patients with a JJ stent could potentially be discharged on postoperative day five, after removal of the transurethral catheter, if all

discharge criteria were achieved. Based on a pilot study on the quality of recovery in kidney transplant recipients (not published), we used a standard deviation of 10 points for the QoR score on postoperative day five. A 6.3-point difference represents a minimal clinically important difference in the QoR-40 scale [17]. A sample size of 40 patients per group was required to provide 90% power to detect a 6.3-point difference in the QoR score at postoperative day five (alpha 5%).

We used the Mann-Whitney *U* test to compare variables that were not normally distributed, presented as median and interquartile range. We used Student's *t*-test to compare normally distributed continuous variables and the chi squared test for categorical variables. Continuous data were presented as mean and SD; categorical data were presented as number and percentages. We used multivariate regression analysis to correct for confounders. We did not perform data imputation. For all analyses, statistical significance was defined as $P < 0.05$. All analyses were performed using SPSS version 22.0 (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp).

3. Results

3.1. Patient characteristics

The process of patient enrolment is depicted in Fig. 1. A total of 95 recipients of living donor kidney transplants were screened for enrolment. Fifteen patients were excluded because they met one of the exclusion criteria. A total of 40 patients were analysed in the PC cohort and another 40 patients in the JJ cohort. Patient baseline characteristics as well as perioperative data are shown in Table 1. Both cohorts were comparable in baseline values, except for a mean age difference of 7.2 years between the PC cohort and the JJ cohort (53.5 ± 13.0 versus 46.4 ± 15.4 ; $p = 0.028$). There were no significant differences in perioperative data. Intraoperative complications did not occur in either

Table 1
Patient characteristics.

| Variables | PC-cohort <i>n</i> = 40 | JJ-cohort <i>n</i> = 40 | <i>P</i> value |
|---------------------------------|-------------------------|-------------------------|----------------|
| Baseline characteristics | | | |
| Age (yrs) | 53.5 ± 13.0 | 46.4 ± 15.4 | 0.03 |
| Gender (male) | 17 (42.5%) | 25 (62.5%) | 0.07 |
| BMI (kg m ⁻²) | 24.3 ± 3.6 | 25.2 ± 3.3 | 0.21 |
| ASA classification (1/2/3/4) | 1/11/28/0 | 0/8/30/2 | 0.32 |
| Diabetes mellitus (yes) | 3 (7.5%) | 5 (12.5%) | 0.46 |
| Dialysis (yes) | 20 (50.0%) | 28 (70.0%) | 0.07 |
| Cause of renal failure: | | | |
| - ADPKD | 5 (12.5%) | 14 (35.0%) | 0.02 |
| - IgA nephropathy | 6 (15.0%) | 5 (12.5%) | 0.75 |
| - Secondary FSGS | 9 (22.5%) | 8 (20.0%) | 0.79 |
| - Other | 20 (50.0%) | 13 (32.5%) | 0.11 |
| Peroperative data | | | |
| Kidney side (left) | 38 (95.0%) | 38 (95.0%) | 1.00 |
| Fossa side (right) | 39 (97.5%) | 33 (82.5%) | 0.08 |
| Size of incision (cm) | 14.2 ± 2.4 | 13.9 ± 2.4 | 0.55 |
| Multiple arteries (yes) | 13 (32.5%) | 6 (15.0%) | 0.07 |
| Duration of surgery (min) | 148.2 ± 35.0 | 149.5 ± 24.5 | 0.86 |
| Total ischaemia time (min) | 150.8 ± 32.4 | 149.9 ± 24.4 | 0.89 |

Abbreviations: PC, percutaneous stent; JJ, double J stent; ADPKD, autosomal dominant polycystic kidney disease; ASA, American Society of Anesthesiologists; BMI, body mass index; cm, centimetres; FSGS, focal segmental glomerulosclerosis; IgA, immunoglobulin A; min, minutes; TUC, trans-urethral catheter; yrs, years; continuous variables are presented as mean ± SD, categorical variables are presented as *n* (%).

group. There is a small number of missing values; on POD three one patient in the PC group did not complete the QoR-40 questionnaire and on POD four and five one patient in the JJ group was unable to complete the QoR-40 questionnaire.

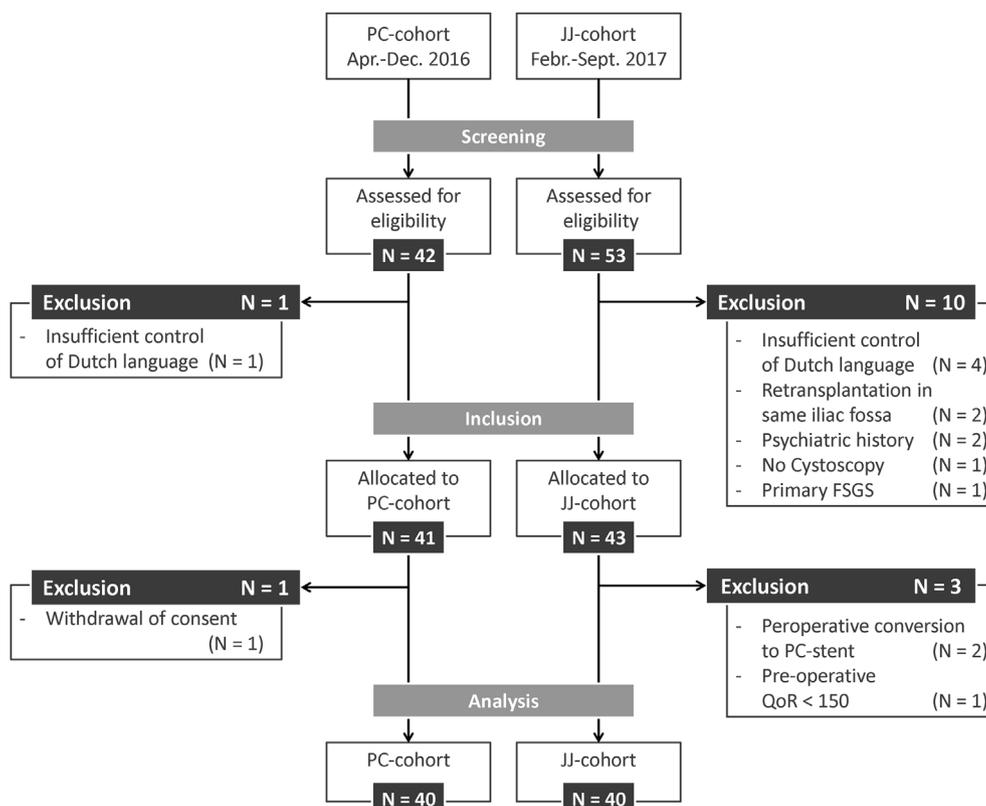


Fig. 1. Patient enrolment.

Abbreviations: PC, percutaneous stent; JJ, double J stent; Apr, April; Dec, December; Febr, February; Sept, September; FSGS, focal segmental glomerulosclerosis; QoR, quality of recovery score.

Table 2
Quality of Recovery score.

| | QoR categories | PC-cohort n = 40 | JJ-cohort n = 40 | P value |
|---------------|-----------------------|--------------------------|--------------------------|--------------|
| POD -1 | Overall score | 192.5 [184.0–197.0] | 195.0 [187.25–198.75] | 0.464 |
| POD 1 | Overall score | 177.0 [166.5–185.75] | 179.0 [164.25–184.75] | 0.586 |
| | Physical comfort | 53.0 [46.5–58.0] | 54.0 [45.5–57.0] | 0.668 |
| | Emotional status | 43.0 [40.0–45.0] | 42.0 [41.0–45.0] | 0.914 |
| | Physical independence | 15.0 [13.0–17.0] | 15.0 [13.25–17.0] | 0.892 |
| | Support | 35.0 [35.0–35.0] | 35.0 [35.0–35.0] | 0.385 |
| | Pain | 32.0 [30.0–34.0] | 31.0 [29.0–34.0] | 0.296 |
| POD 2 | Overall score | 183.5 [174.25–191.75] | 187.0 [181.0–193.0] | 0.176 |
| | Physical comfort | 56.0 [52.0–59.0] | 58.0 [54.0–60.0] | 0.168 |
| | Emotional status | 44.0 [41.0–45.0] | 44.0 [41.0–45.0] | 0.323 |
| | Physical independence | 16.75 [15.0–21.0] | 19.0 [16.0–21.0] | 0.362 |
| | Support | 35.0 [35.0–35.0] | 35.0 [35.0–35.0] | 0.084 |
| | Pain | 33.0 [31.0–34.75] | 33.0 [31.0–35.0] | 0.604 |
| POD 3 | Overall score | 185.0 [174.0–193.0] | 191.0 [184.0–195.75] | 0.019 |
| | Physical comfort | 56.0 [51.0–59.0] | 58.0 [56.0–60.0] | 0.068 |
| | Emotional status | 42.0 [38.0–45.0] | 44.5 [43.0–45.0] | 0.004 |
| | Physical independence | 19.0 [16.0–21.0] | 21.0 [19.0–23.0] | 0.017 |
| | Support | 35.0 [35.0–35.0] | 35.0 [35.0–35.0] | 0.445 |
| | Pain | 33.0 [32.0–35.0] | 33.0 [31.0–35.0] | 0.908 |
| POD 4 | Overall score | 186.0 [179.25–194.0] | 192.0 [181.0–195.0] | 0.231 |
| | Physical comfort | 57.0 [54.0–59.0] | 58.0 [55.0–60.0] | 0.302 |
| | Emotional status | 43.0 [41.0–44.75] | 44.0 [41.0–45.0] | 0.417 |
| | Physical independence | 21.0 [18.0–22.0] | 21.0 [20.0–23.0] | 0.083 |
| | Support | 35.0 [35.0–35.0] | 35.0 [35.0–35.0] | 0.551 |
| | Pain | 33.5 [31.25–35.0] | 33.0 [32.0–34.0] | 0.415 |
| POD 5 | Overall score | 189.5 [179.5–194.75] | 193.0 [188.0–197.0] | 0.021 |
| | Physical comfort | 57.0 [53.25–59.0] | 59.0 [57.0–60.0] | 0.010 |
| | Emotional status | 43.5 [41.0–45.0] | 43.0 [42.0–45.0] | 0.381 |
| | Physical independence | 21.0 [19.0–23.0] | 23.0 [21.0–24.0] | 0.016 |
| | Support | 35.0 [35.0–35.0] | 35.0 [35.0–35.0] | 0.167 |
| | Pain | 33.5 [30.0–35.0] | 34.0 [32.0–35.0] | 0.415 |

Range of QoR scores: overall, 40–200; physical comfort, 12–60; emotional status, 9–45; physical independence, 5–25; support, 7–35; pain, 7–35; Abbreviations: QoR, quality of recovery; PC, percutaneous stent; JJ, double J stent; POD, postoperative day; variables are presented as median [IQR].

3.2. Primary outcome measure

The Quality of Recovery questionnaire was completed daily during hospital stay. The data are shown in Table 2. On postoperative day five, higher total QoR scores were observed in the JJ group, when compared to the PC group (193.0 (IQR 188–197) versus 189.5 (IQR 179.5–194.75); $p = 0.021$). Also on postoperative day three, total QoR score was higher in patients in the JJ cohort (191.0 (IQR 184–195.75)) than in patients in the PC cohort (185.0 (IQR 174–193); $p = 0.019$). Patients in the JJ cohort had significantly higher scores in the physical independence subscale on postoperative day three and day five. Correction for age by multivariate regression analysis did not affect the results.

3.3. Postoperative characteristics, discharge criteria and length of hospital stay

Postoperative intervals between transplantation and removal of the surgical drain, removal of the ureteric stent, removal of the transurethral catheter, performance of the ultrasound and day of discharge are shown in Table 3. Postoperative recovery was also assessed by daily scoring of discharge criteria. As shown in Table 4, patients in the JJ

Table 3
Secondary outcomes.

| Variables | PC-cohort n = 40 | JJ-cohort n = 40 | P value |
|---|------------------|------------------|---------|
| Median day of surgical drain removal | 3 [1–18] | 2 [1–26] | 0.55 |
| Median day of stent removal | 5 [5–7] | 20 [14–34] | < 0.001 |
| Median day of TUC removal | 7 [7–9] | 5 [5–7] | < 0.001 |
| Median day of ultrasound | 7 [7–9] | 6 [5–7] | < 0.001 |
| Median day of discharge | 7 [7–19] | 6 [5–14] | < 0.001 |
| Mean creatinine level at discharge (μmol/L) | 111.4 ± 54.0 | 125.0 ± 37.6 | 0.19 |
| Cumulative opiate consumption (mg) | 25.73 ± 29.49 | 21.23 ± 21.03 | 0.43 |

Abbreviations: PC, percutaneous stent; JJ, double J stent; TUC, transurethral catheter; continuous variables are presented as median [range] or mean ± SD, categorical variables are presented as n (%).

cohort achieved all classic surgical discharge criteria earlier than patients in the PC cohort. Patients with a JJ stent, showed earlier pain control with oral analgesics and they were faster in mobilising and achieving independence in daily activities. On postoperative day five, 97.5% of the patients with a JJ stent versus 80% of the patients with a PC stent reached all classic surgical discharge criteria ($p = 0.013$). However, discharge after living donor kidney transplantation at the Radboudumc also depends on transurethral catheter removal, stable graft function, patient control over use of immunosuppressive drugs, and performance of an ultrasound. Patients could be discharged, when they met all these criteria, and no other problems occurred. As presented in Fig. 2, patients in the PC cohort were admitted at least until POD 7, due to the transurethral catheter policy. Thirty percent of the patients in the JJ cohort were already discharged on POD five, since the transurethral catheter in patients with a JJ stent was removed on POD five (except in patients with diabetes). Logistical barriers to perform the postoperative ultrasound on the same day as removal of the transurethral carrier was a limiting factor for discharge on POD five. On POD six, 30 patients from the JJ cohort (75%) had been discharged, increasing to 92.5% on POD seven. In the PC cohort only 62.5% of the patients had been discharged on POD seven ($p = 0.001$ for difference with JJ cohort). The mean time of discharge in the JJ cohort and the PC cohort was 6.20 ± 1.56 versus 7.95 ± 2.12 days after surgery ($p < 0.001$). The mean serum creatinine level at discharge was comparable between both cohorts.

3.4. Postoperative complications

All complications and their Clavien-Dindo classification are presented in Table 5. There were no significant differences in the number of patients with postoperative complications within 30 days after surgery. In both cohorts, 7/40 patients suffered from a urological complication, including urinary leakage, ureteral obstruction, symptomatic lymphocele, UTI and blood clot retention.

3.5. Follow-up

Follow-up was performed after two to three weeks. There were no significant differences in the QoR scores between the two cohorts, both had a median score of 194. Lower urinary tract symptoms were evaluated using the ICIQ-LUTS. There were no differences between both cohorts with regard to urinary frequency, nocturia, urge complaints, dysuria and bladder pain. Three patients reported moderate pain and one patient reported severe pain during JJ-stent removal by cystoscopy.

4. Discussion

This is the first prospective cohort study comparing the influence of PC stents and JJ stents on the quality of recovery and the length of

Table 4
Classic surgical discharge criteria.

| POD | Classic surgical discharge criteria | PC cohort n = 40 | JJ cohort n = 40 | P value |
|-------|---|------------------|------------------|---------|
| POD 1 | 1. Pain controlled with oral analgesics | 3 (7.5%) | 4 (10.0%) | 1.000 |
| | 2. Tolerance for normal diet | 8 (20.0%) | 12 (30.0%) | |
| | 3. Having flatus or defaecation | 26 (65.0%) | 31 (77.5%) | |
| | 4. Mobilising on the ward | 0 (0.0%) | 2 (5.0%) | |
| | 5. Independence for daily activities | 0 (0.0%) | 0 (0.0%) | |
| | Reached all classic discharge criteria | 0 (0.0%) | 0 (0.0%) | |
| POD 2 | 1. Pain controlled with oral analgesics | 20 (50.0%) | 25 (62.5%) | 0.235 |
| | 2. Tolerance for normal diet | 39 (97.5%) | 38 (95.0%) | |
| | 3. Having flatus or defaecation | 39 (97.5%) | 40 (100.0%) | |
| | 4. Mobilising on the ward | 13 (32.5%) | 14 (35.0%) | |
| | 5. Independence for daily activities | 3 (7.5%) | 5 (12.5%) | |
| | Reached all classic discharge criteria | 2 (5.0%) | 5 (12.5%) | |
| POD 3 | 1. Pain controlled with oral analgesics | 33 (82.5%) | 39 (97.5%) | 0.012 |
| | 2. Tolerance for normal diet | 39 (97.5%) | 39 (97.5%) | |
| | 3. Having flatus or defaecation | 40 (100.0%) | 40 (100.0%) | |
| | 4. Mobilising on the ward | 26 (65.0%) | 37 (92.5%) | |
| | 5. Independence for daily activities | 11 (27.5%) | 22 (55.0%) | |
| | Reached all classic discharge criteria | 10 (25.0%) | 21 (52.5%) | |
| POD 4 | 1. Pain controlled with oral analgesics | 40 (100.0%) | 40 (100.0%) | 0.045 |
| | 2. Tolerance for normal diet | 39 (97.5%) | 39 (97.5%) | |
| | 3. Having flatus or defaecation | 40 (100.0%) | 40 (100.0%) | |
| | 4. Mobilising on the ward | 35 (87.5%) | 39 (97.5%) | |
| | 5. Independence for daily activities | 25 (62.5%) | 33 (82.5%) | |
| | Reached all classic discharge criteria | 25 (62.5%) | 33 (82.5%) | |
| POD 5 | 1. Pain controlled with oral analgesics | 40 (100.0%) | 40 (100.0%) | 0.013 |
| | 2. Tolerance for normal diet | 40 (100.0%) | 40 (100.0%) | |
| | 3. Having flatus or defaecation | 40 (100.0%) | 40 (100.0%) | |
| | 4. Mobilising on the ward | 39 (97.5%) | 40 (100.0%) | |
| | 5. Independence for daily activities | 32 (80.0%) | 39 (97.5%) | |
| | Reached all classic discharge criteria | 32 (80.0%) | 39 (97.5%) | |

Abbreviations: PC, percutaneous stent; JJ, double J stent; POD, postoperative day; variables are presented as n (%).

hospital stay in living donor kidney transplantation. The removal of the transurethral catheter appeared to be a decisive factor for the length of hospital stay in our hospital. In the JJ cohort, the transurethral catheter

was removed two days earlier when compared to the PC cohort, as the ureterovesical junction is protected by the indwelling JJ stent. Furthermore, our data show that the use of JJ stents leads to an

PC-stent (N = 40)

| POD | Classic criteria | TUC removed | Stable graft function | Independent in drug use | Ultrasound performed | No other problems | Discharged (% of pts.) |
|-----|------------------|-------------|-----------------------|-------------------------|----------------------|-------------------|------------------------|
| 5 | 32 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| 6 | 36 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| 7 | 37 | 34 | 31 | 31 | 30 | 25 | 62.5% |
| 8 | 38 | 36 | 34 | 34 | 34 | 32 | 80.0% |
| 9 | 39 | 39 | 38 | 38 | 38 | 37 | 92.5% |

JJ-stent (N = 40)

| POD | Classic criteria | TUC removed | Stable graft function | Independent in drug use | Ultrasound performed | No other problems | Discharged (% of pts.) |
|-----|------------------|-------------|-----------------------|-------------------------|----------------------|-------------------|------------------------|
| 5 | 39 | 32 | 31 | 28 | 16 | 12 | 30.0% |
| 6 | 40 | 35 | 34 | 33 | 33 | 30 | 75.0% |
| 7 | → | 40 | 38 | 37 | 37 | 37 | 92.5% |
| 8 | → | → | 39 | 38 | 38 | 38 | 95.0% |
| 9 | → | → | 39 | 39 | 39 | 39 | 97.5% |

Fig. 2. Discharge process.

Each cell represents the number of patients who fulfilled the specific discharge criteria on that postoperative day. The 3 remaining patients in the PC cohort were discharged on POD 11, 12 and 19. The remaining patient in the JJ cohort was discharged on POD 14.

Abbreviations: PC, percutaneous stent; JJ, double J stent; POD, postoperative day; TUC, transurethral catheter; pts, patients.

Table 5a
Complications within 30 days.

| | Severity (Clavien-Dindo) | PC stent n = 40 | JJ stent n = 40 | P value |
|---|-----------------------------|------------------------|------------------------|---------|
| Nr. of patients with complications | All 1/2/3a/3b | 28 (70.0%) 13/8/3/4 | 22 (55.0%) 6/10/5/1 | 0.17 |
| Nr. of patients with urological complications | All 1/2/3a/3b | 7 (17.5%) 2/0/2/3 | 7 (17.5%) 1/1/5/0 | 1.00 |

Table 5b
Type of complications.

| | Severity (Clavien-Dindo) | PC stent n = 40 | JJ stent n = 40 |
|--|-----------------------------|-----------------|--------------------|
| Urinary leakage | 1 3b | 1 1 | 1 0 |
| Ureteral obstruction | 1 3a 3b | 1 1 1 | 0 1 0 |
| Urinary tract infection (UTI) | 2 | 0 | 2 |
| Symptomatic lymphocele | 3a | 1 | 5 |
| Postoperative bleeding | 1 3a 3b | 1 1 2 | 0 0 1 |
| Slow graft function | 1 | 1 | 0 |
| Delayed graft function | 3a | 1 | 0 |
| Rejection | 2 | 1 | 2 |
| Tacrolimus toxicity | 1 | 1 | 1 |
| Newly onset diabetes after transplantation | 2 | 4 | 4 |
| Disturbed liver function tests | 1 | 10 | 3 |
| Electrolyte disorders | 1 | 0 | 2 |
| Diarrhoea, caused by MMF | 1 | 1 | 1 |
| Infection, other than UTI | 1 2 | 2 5 | 0 2 |
| Psychiatric disorder | 2 | 0 | 1 |

Abbreviations: PC, percutaneous stent; JJ, double J stent; nr, number; UTI, urinary tract infection; MMF, mycophenolate mofetil; variables are presented as n (%).

improved quality of recovery. Consequently, patients with a JJ stent were earlier independent in daily activities and showed a quicker achievement of discharge criteria, resulting in a shorter length of hospital stay, without compromising in the number of postoperative complications.

When compared to the PC cohort, we found significant higher QoR scores in the JJ cohort on POD 3, with a mean difference of 6.0. On POD 4, the PC group catches up on recovery, causing no significant difference in QoR scores. However, on POD 5, when in most patients of the JJ cohort the transurethral catheter was removed, the JJ group had another head start over the PC group, with a mean difference in QoR scores of 3.5. According to Myles and colleagues, the minimal clinically important difference is 6.3 [17]. However, the discharge criteria and length of hospital stay, confirm a quicker recovery in the patients with a JJ stent, when compared to a PC stent.

We found no significant differences in the urological complication rates between the JJ group and the PC group within our study. Urinary leakage occurred in two patients in the PC group, versus one patient in the JJ group. Ureteral obstruction occurred in three patients with a PC stent, versus one patient with a JJ stent (after removal of the JJ). Three of these patients in the PC group underwent ureteral drainage by a JJ stent or nephrostomy tube. In one patient in the JJ group, the JJ stent was replaced. Only two patients suffered from a UTI, both in the JJ cohort. A remarkable finding, was the increased number of symptomatic lymphoceles in the JJ group, when compared to the PC group (5 versus 1; $p = 0.09$). This finding can possibly be explained by the higher

number of patients with autosomal dominant polycystic kidney disease (ADPKD) in the JJ group (see Table 1). ADPKD is a known risk factor for postoperative lymphocele development [18,19]. Lymphatic drainage can possibly be impaired by the enlarged native kidneys that compress the inferior caval vein or by retroperitoneal scarring and fibrosis following nephrectomy. In the JJ cohort, three of the five patients with a lymphocele had ADPKD. Nevertheless, this study was not powered to draw conclusions on the influence of the stent design on the incidence of urological complications.

A few patients experienced moderate to severe pain during the removal of the JJ stent. Therefore, it is important to assess preoperatively whether patients are suitable for cystoscopy. A possible solution to remove the JJ stent without the need for a bothersome cystoscopy could be a magnetic-tipped JJ stent. This is a ureteral stent with a small magnetic cube fixed on the loop of the distal part of the stent. To remove the JJ stent, a special catheter-like instrument with a magnetic tip can be used, which is less painful and faster when compared to cystoscopy [20].

A limitation of this study is the non-randomised design. It was not possible to perform a randomised clinical trial due to logistical challenges. Nevertheless, the risk of selection bias is low, as we performed two consecutive cohorts, and all patients scheduled for living donor kidney transplantation were included, if they fulfilled all inclusion criteria. Baseline characteristics were comparable, except for a younger age in the JJ group. However, we performed multivariate analysis for this confounding factor, which did not alter the outcomes.

5. Conclusions

The use of JJ stents during living donor kidney transplantation improves the quality of recovery and shortens the length of hospital stay, when compared to PC stents. We advocate the use of JJ stents as part of an enhanced recovery protocol in living donor kidney transplantation. Future randomised studies are required to confirm that a JJ stent does not negatively affect the incidence and severity of postoperative urological complications, when compared to a PC stent.

Ethical approval

The trial was approved by the local ethics committee, the Central Committee on Research involving Human Subjects, Arnhem-Nijmegen, The Netherlands, reference number 2016–2426 (Chairperson R.B. Keus) on 6 April 2016.

Sources of funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author contribution

Moira Bruintjes: conception and study design, overall direction and planning, data collection, data analysis, data interpretation, original draft, and approval of the final version.

Johan Langenhuijsen: conception and study design, data interpretation, critical revision and approval of the final version.

Anneke Kusters: overall direction and planning, data collection, data interpretation, critical revision and approval of the final version.

Luuk Hilbrands: conception and study design, data interpretation, critical revision and approval of the final version.

Frank d'Ancona: conception and study design, data interpretation, original draft, critical revision and approval of the final version.

Michiel Warlé: conception and study design, data analysis, data interpretation, original draft, critical revision and approval of the final version.

Research registration number

1. Name of the registry: Research Registry
2. Unique Identifying number or registration ID: researchregistry5073
3. Hyperlink to the registration (must be publicly accessible): <https://www.researchregistry.com/browse-the-registry#home/registrationdetails/5d51afcdc42de30012b0cacb/>

Guarantor

Michiel C. Warlé.
F.C.H. d'Ancona.
Moira H.D. Bruintjes.

Declaration of competing interest

Dr. M.C. Warlé reports grants from Merck Sharp and Dohme, outside the submitted work. The other authors have nothing to declare.

Acknowledgements

The authors thank Esmee van Helden for the contribution to the data acquisition.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ijvs.2019.09.031>.

References

- [1] C.H. Wilson, D.A. Rix, D.M. Manas, Routine intraoperative ureteric stenting for kidney transplant recipients, *Cochrane Database Syst. Rev.* 6 (2013) Cd004925.
- [2] R.S. Mangus, B.W. Haag, Stented versus nonstented extravesical ureteroneocystostomy in renal transplantation: a metaanalysis, *Am. J. Transplant.* 4 (2004) 1889–1896.
- [3] M.M. Fockens, V.P. Alberts, F.J. Bemelman, M.P. Laguna Pes, M.M. Idu, Internal or external stenting of the ureterovesical anastomosis in renal transplantation, *Urol. Int.* 96 (2016) 152–156.
- [4] M. Jakob, N. Strupler, D. Candinas, U. Huynh-Do, G. Beldi, Externalized percutaneous stent versus internal double J stent: short- and long-term complications after kidney transplantation, *Transplant. Proc.* 50 (2018) 3416–3421.
- [5] C.M. Simpson, J.A. Sterne, R.G. Walker, D.M. Francis, A.J. Robertson, C.L. Jones, Stent-related ureteric obstruction in paediatric renal transplantation, *Pediatr. Nephrol.* 21 (2006) 79–85.
- [6] T. Vogel, M. Utech, F. Schmidt, W. Holscher Keplin, R. Diller, J. Brockmann, H. Wolters, Double-j versus external ureteral stents in kidney transplantation: a retrospective analysis, *Nephro-Urol. Mon.* 7 (2015) e27820.
- [7] C. Argyrou, D. Moris, S. Vernadakis, Steering between Scylla and Charybdis: picking out the optimum time of double-J stent removal following renal transplantation, *Transplant. Rev.* 31 (2017) 96–99.
- [8] J.F. Cai, W. Wang, W. Hao, Z.J. Sun, L.L. Su, X. Li, X. Zheng, X.D. Zhang, Meta-analysis of early versus late ureteric stent removal after kidney transplantation, *Transplant. Proc.* 50 (2018) 3411–3415.
- [9] E.R. Thompson, S.A. Hosgood, M.L. Nicholson, C.H. Wilson, Early versus late ureteric stent removal after kidney transplantation, *Cochrane Database Syst. Rev.* 1 (2018) Cd011455.
- [10] M. Greco, G. Capretti, L. Beretta, M. Gemma, N. Pecorelli, M. Braga, Enhanced recovery program in colorectal surgery: a meta-analysis of randomized controlled trials, *World J. Surg.* 38 (2014) 1531–1541.
- [11] U.O. Gustafsson, M.J. Scott, M. Hubner, J. Nygren, N. Demartines, N. Francis, et al., Guidelines for perioperative care in elective colorectal surgery: enhanced recovery after surgery (ERAS(R)) society recommendations: 2018, *World J. Surg.* 43 (2019) 659–695.
- [12] R.A. Agha, M.R. Borrelli, M. Vella-Baldacchino, R. Thavayogan, D.P. Orgill, The STROCSS statement: strengthening the reporting of cohort studies in surgery, *Int. J. Surg.* 46 (2017) 198–202.
- [13] P.S. Myles, B. Weitkamp, K. Jones, J. Melick, S. Hensen, Validity and reliability of a postoperative quality of recovery score: the QoR-40, *Br. J. Anaesth.* 84 (2000) 11–15.
- [14] D. Dindo, N. Demartines, P.A. Clavien, Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey, *Ann. Surg.* 240 (2004) 205–213.
- [15] D. Mitropoulos, W. Artibani, C.S. Biyani, J. Bjerggaard Jensen, M. Roupret, M. Truss, Validation of the Clavien-Dindo grading system in urology by the European association of urology guidelines ad hoc panel, *Eur Urol Focus* 4 (2017) 608–613.
- [16] K. Avery, J. Donovan, T.J. Peters, C. Shaw, M. Gotoh, P. Abrams, ICIQ: a brief and robust measure for evaluating the symptoms and impact of urinary incontinence, *Neurourol. Urodyn.* 23 (2004) 322–330.
- [17] P.S. Myles, D.B. Myles, W. Gallagher, C. Chew, N. MacDonald, A. Dennis, Minimal clinically important difference for three quality of recovery scales, *Anesthesiology* 125 (2016) 39–45.
- [18] A. Ranghino, G.P. Segoloni, F. Lasaponara, L. Biancone, Lymphatic disorders after renal transplantation: new insights for an old complication, *Clin Kidney J* 8 (2015) 615–622.
- [19] M.C.H. Zubair, M. Mehboob, H. Ishaqi, Z.A. Khoso, Post-renal transplant lymphorrhea and lymphocele: an unusual association with autosomal dominant polycystic kidney disease, *World J Surg Surgical Res* 2 (2019) 1085.
- [20] M.C. Rassweiler, M.S. Michel, M. Ritter, P. Honeck, Magnetic ureteral stent removal without cystoscopy: a randomized controlled trial, *J. Endourol.* 31 (2017) 762–766.