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Use of percutaneous nephrostomy and ureteral stenting in management of ureteral obstruction

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Abstract

The management options for ureteral obstruction are diverse, including retrograde ureteral stent insertion or antegrade nephrostomy placement, with or without eventual antegrade stent insertion. There is currently no consensus on the ideal treatment or treatment pathway for ureteral obstruction owing, in part, to the varied etiologies of obstruction and diversity of institutional practices. Additionally, different clinicians such as internists, urologists, oncologists and radiologists are often involved in the care of patients with ureteral obstruction and may have differing opinions concerning the best management strategy. The purpose of this manuscript was to review available literature that compares percutaneous nephrostomy placement *vs* ureteral stenting in the management of ureteral obstruction from both benign and malignant etiologies.

Key words: Percutaneous nephrostomy; Urinary diversion; Ureteral obstruction; Quality of life; Ureteral stents; Pelvic malignancy; Urinary drainage

Core tip: Ureteral obstruction as a consequence of malignant or benign etiologies is a common urologic entity that is often challenging for clinicians to determine the optimal method of urinary decompression. There is no consensus on the use of stents *vs* percutaneous nephrostomy in the management of ureteral obstruction as well as a lack of clear superiority of stenting over percutaneous approach in terms of complications and quality of life considerations. Therefore, treatment decisions must be individualized using a multidisciplinary approach involving the patients, their family and members of the treatment team.

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INTRODUCTION

Ureteral obstruction is a heterogeneous clinical entity, and it is often challenging for the clinician to determine the optimal method of decompression. Malignant ureteral obstruction can arise from intrinsic urologic malignancy such as prostate or bladder cancer, or extrinsic involvement from another primary malignancy, most commonly of gynecologic or colorectal origin[1-3]. The therapeutic goal of urinary drainage in malignant disease is to adequately drain the upper urinary tracts for symptomatic relief with maintenance of renal function, allowing the initiation of systemic therapy while minimizing further urologic intervention, hospitalization and negative impact on the quality of life[2-4]. On the other hand, the etiology of benign ureteral obstruction is generally a consequence of intraluminal pathology, such as ureteropelvic junction obstruction, ureteral stones or ureteral stenosis. Extraluminal benign obstruction can arise from localized mass effect of benign tumors such as uterine leiomyomas or retroperitoneal fibrosis[5-7]. Benign ureteral obstruction caused by ureteropelvic junction obstruction is primarily managed with definitive treatment of the underlying condition[8].

There are no clear guidelines regarding optimal methods of urinary decompression in the management of ureteral obstruction. The purpose of this article is to review recent literature assessing outcomes of retrograde ureteral stenting and percutaneous nephrostomy (PCN) insertion in the treatment of ureteral obstruction resulting from malignant and benign etiologies to elucidate the associated morbidity, effects on quality of life and variability in technical success.

DATA ACQUISITION

PubMed was used to search for articles addressing the management of malignant and benign ureteral obstruction using key phrases "ureteral stent" and "nephrostomy". This yielded 850 articles that were screened by title and abstract. Screened articles were then independently evaluated by two authors (HL and LH) for inclusion in the review. Manuscripts were included if they reported original research comparing PCN and ureteral stenting. Exclusion criteria included a study focus on pediatric populations, no differentiation between antegrade *vs* retrograde stenting, or study population totaling < 10. A total of 16 articles were included in the final review.

PCN *VS* URETERAL STENTING IN THE SETTING OF MALIGNANCY

Malignant ureteral obstruction may occur secondary to contiguous tumor invasion, extrinsic ureteral compression by pelvic malignancies, or by pelvic metastases of tumors that originate from outside the pelvis such as breast, gastric or pancreatic cancers. Obstruction can also occur in the setting of retroperitoneal or pelvic lymphadenopathy due to metastatic disease, or as a consequence of treatment resulting in retroperitoneal fibrosis or ureteral stricture[9,10].

Obstruction may be evident during staging of the disease or workup for impaired renal function as evidenced by hydronephrosis with renal cortical atrophy on abdominal imaging. Additionally, patients may experience acute flank pain, renal failure, uremia or sepsis secondary to urinary tract infections. The rationale for decompression aims to offer relief of the above symptoms, to alleviate complications from renal insufficiency and to facilitate systemic therapy.

Determining the etiology of obstruction may be helpful in planning treatment approaches as tumors involving the bladder, uterine cervix and prostate cancer are known to have lower retrograde stenting success rates[11]. The etiology of obstruction is also important for estimating patient prognosis. Non-urologic malignancies such as gastric and pancreatic cancers have a worse prognosis with shorter overall survival than urologic malignancies[12,13].

Prognostication and quality of life: To decompress or not to decompress?

Although the intention of diversion is to prolong patient survival, this goal is often not achieved with diversion. Malignant ureteral obstruction can be a sign of advanced disease[14,15] and patients with ureteral obstruction secondary to advanced malignancies traditionally have poor life expectancy measured in months even if relief of ureteral obstruction is achieved. In a prospective study of 205 patients with obstructive uropathy secondary to advanced cervical cancer, urinary diversion with PCN drainage or ureteral stenting was found to be associated with modest survival advantage in the months immediately after diversion[16]. However, there was no significant difference in quality of life when compared to patients who elected not to undergo diversion[16]. In contemporary studies, the median survival of patients with ureteral obstruction secondary to pelvic malignancies after urinary diversion ranges from 96 to 144 d[17,18], with 88% mortality within one year of decompression[18].

Objective criteria have been studied to prognosticate survival after urinary diversion in patients with ureteral obstruction secondary to advanced malignancy. Ishioka *et al*[18] studied survival in 140 patients with urinary obstruction secondary to advanced incurable malignancies

and identified predictors of poor prognosis associated with shorter survival time after palliative urinary diversion by PCN: Serum albumin before diversion (≤ 3 g/dL), degree of hydronephrosis (grade 1 or 2) and three or more events related to disseminated malignancy[18]. Patients with 2 or 3 of these predictors had a 2% survival rate at 6 mo while patients with none of these characteristics had a 69% survival rate[18]. Cordeiro *et al*[17], in a prospective study of 208 patients who underwent ureteral stenting or PCN for malignant ureteral obstruction, identified the number of events related to malignancy ≥ 4 and Eastern Cooperative Oncology Group (ECOG) index ≥ 2 to be significantly associated with poor prognosis after urinary diversion with a median survival rate of 7.1% at 12 mo in the unfavorable risk group[17]. On the basis of these findings, ureteral stenting and nephrostomy tubes may not be indicated in poor risk patients.

Following ureteral stenting or PCN placement, quality of life may be impaired secondary to irritative urinary symptoms, pain, need for tube changes on a regular basis and often worse performance status[19,20]. In a prospective direct comparison of the quality of life after nephrostomy or stent placement in 46 patients with malignant urinary tract obstruction, Monsky *et al*[19] found no significant difference in the quality of life between treatment groups based on standardized validated surveys. In this study, patients managed with stenting reported more irritative voiding symptoms and pain while patients undergoing nephrostomy placement required more frequent tube changes secondary to complications.

In summary, there is no clear evidence that urinary diversion in the setting of malignant urinary obstruction improves the quality of life. Additionally, no significant difference has been reported between the two diverting modalities. Urinary decompression may be justified if improvement in renal function will facilitate systemic therapy and alleviate symptoms of ureteral obstruction. However, with an understanding that this specific condition entails poor prognosis, all treatment decisions must be decided on an individual basis with a multidisciplinary approach involving the patients, their family, and members of the treatment teams.

Complications of PCN and retrograde ureteral stenting

The complications profile differs for ureteral stents and nephrostomy tubes and warrants consideration when managing malignant ureteral obstruction. Patients with ureteral stents commonly experience irritative lower urinary tract symptoms and somatic pain, requiring some form of analgesia in up to 70% of patients within seven days of the procedure[21]. Other complications such as stent failure from encrustation and obstruction, ureteral perforation, stent migration, stent fracture and the forgotten stent have been well documented[22-24]. Mild hematuria is common after ureteral stenting as a result of urothelial irritation. Significant hematuria after ureteral stenting can be caused by arterio-ureteral fistula between the ureter and the common or internal iliac arteries. This rare phenomenon has been reported in the setting of pelvic malignancies treated with surgery and radiation[22]. On the other hand, external tubes and drainage bags as a part of daily PCN care have associated complications involving tube blockage, leakage and dislodgement requiring additional tube changes in up to 83% of patients compared to 16% with ureteral stents[19]. Inadvertent bowel transgression is a rare complication of PCN when the colon lies in a retrorenal position. Pleural complications including pneumothorax, hemothorax, empyema, and hydrothorax may occur in less than 0.1%-0.2% of patients[25]. Bleeding and gross hematuria may occur from puncture of intercostal vascular structures or parenchymal vessels, which are usually self-limited, requiring transfusion in 2%-4% of standard nephrostomy insertions[22]. Late arterial bleeding occurs from pseudoaneurysms, arterio-venous and arterial calyceal fistulas secondary to injury of renal arterial branches[22]. In a study by Song *et al*[26] of 70 patients managed with PCN *vs* ureteral stenting for gynecologic malignancies, 14% of patients who underwent stenting were noted to have gross hematuria one week after insertion and 8% of patients had severe hematuria after PCN insertion secondary to cancer-related poor coagulation states. These complications were managed conservatively without need for acute intervention. In addition, there was no statistically significant difference in the overall complication rates between the two groups of patients[26].

Inflammatory systemic complications such as sepsis, febrile urinary tract infections and pyelonephritis may develop as a consequence of drainage and manipulation of potentially infected, obstructed urinary systems, which are further compounded by the immunosuppressive state of advanced malignancy and subsequent systemic treatments. In studies of ureteral obstruction in advanced malignancies, Cordeiro *et al*[17] reported a higher proportion of pyelonephritis in patients treated with PCN *vs* ureteral stenting (P = 0.002). Conversely, Ku *et al*[27] reported acute pyelonephritis affecting 5.9% of patients managed with ureteral stents and 3.8% of patients with percutaneous nephrostomies, and febrile episodes in 10% and 15%, respectively. There was no statistically significant difference in the overall stent-related or nephrostomy-related complications as well as the accumulated incidence of inflammatory systemic complications between the two groups[27]. Similarly, no significant difference was observed in the incidence of urinary tract infections between the two treatment modalities[19].

While complications of PCN and ureteral stenting are well documented in the literature with variable incidences, data from comparative analyses of the two modalities are limited (Table 1), PCN and ureteral stent placement have comparable overall complication rates based on available evidence. Neither cystoscopic stent placement nor PCN insertion is exempt from major complications such as bleeding and sepsis or minor complications associated

Table 1 Percutaneous nephrostomy *vs* retrograde stent in malignant ureteral obstruction

Ref.	Study design	Cohort	Diagnosis	Stent	Complications	Nephrostomy	Complications	Mortality	Conclusions
Feng *et al*[1], 1999	Retrospective, 1984-1996	*n* = 37 (20 female) patients with ureteral obstruction due to pelvic malignancy	Diuretic renogram or abdominal CT scan	22/31 underwent successful stent placement, 13/31 (42%) remained successfully diverted with stents	Migration (1), encrustation requiring cystolitholapaxy (1), intractable pain requiring repositioning (2)	6 had primary PCN placement, 9/31 had PCN placed due to unsuccessful placement of stent, 6/22 had PCN placed due to failed internal stent, 3 failed stent but did not have PCN placement	Dislodgement requiring reinsertion (3)	NR	33% of patients with disease confined to primary organ or locally advanced disease were managed successfully by stents *vs* 36% of patients with distant metastases, 92% of cervical cancer patients required PCN (89% failed initial internal stents), 50% of prostate cancer patients required PCN but 100% of patients who initially had successful stent placement did not require PCN at average follow-up of 15 mo, 100% colon cancer patients required PCN due to failure of internal stents
Hyppolite *et al*[32], 1995	Retrospective, 1989-1994	*n* = 34 females with gynecologic malignancy	US and serum cr > 1.5 mg/dL	8 (3 had PCN as well)	6/7 (86%) developed urosepsis	17 (unilateral/ bilateral)	7/17 (41%) (1 urosepsis, 3 bleeding, 3 urine leak)	2/34 died within 2 wk and declined intervention, 3/7 who underwent stent placement died from urosepsis from procedure	Stenting predisposes to urosepsis and should be avoided. Bilateral nephrostomy allows significant improvement of renal function
Kanou *et al*[48], 2007	Retrospective, 1990-2003	*n* = 75 (45 female) patients with pelvic malignancy, patients with normal excretion from 1 kidney excluded	NR, need for primary PCN reported to be based on CT, MRI, or cystoscopic evaluation	37/51 underwent successful stent placement, 29/37 (78%) remained successful	Earlier replacement (5), discomfort requiring no intervention (2)	24 had primary PCN placement, 14/51 had PCN due to inability to place stent, 8/37 had PCN placed after failed stent	Dislodgement (9), obstruction requiring exchange (4), difficulty in exchange (2), pain/ dermatitis (3), minor hemorrhage (2)	66/75 with mean survival of 5.9 (PCN) and 5.6 mo (stent)	Higher percentage (78%) of success may be related to utilizing stents without shaft side holes
Ku *et al*[27], 2004	Retrospective, 2000-2002	*n* = 148 (80 female) patients with advanced malignancy causing ureteral obstruction	US, CT, or MRI with high grade obstruction, impaired renal function, clinical symptoms, or febrile UTI	68 (5 had antegrade stent placement), 60/68 (89%) remained successful	8 (11.8%)	80 (5 secondary PCN after failed stent placement), 1/80 failed PCN	7 (8.8%)	NR	Stenting and PCN placement have similar outcomes in terms of decreases in serum creatinine, complications, and incidence of pyelonephritis but significant differences in failure (11% stent *vs* 1.3% PCN) suggesting that patients with retrograde stenting may have ongoing obstruction requiring eventual PCN placement
Monsky *et al*[19], 2013	Prospective survey	*n* = 30 (16 female) patients with malignancy-related ureteral obstruction	Initially evaluated by symptoms of urinary obstruction such as pain, deterioration of renal function, or infection and confirmed by CT	15 patients (22 stents)	Dislodgement (1), Pain (1), Infection (1), Fistula (1)	15 patients (24 PCN)	Dislodgement (7), Pain (4), Infection (3) Obstruction (4), Leak (1)	2/30	Patients with PCN or stents have similar QOL. Patient with stents have more irritative symptoms while PCN may experience more minor complications requiring more frequent changes
Song *et al*[26], 2012	Retrospective, 2006-2010	*n* = 75 females with gynecologic malignancy	US, CT, or MRI with hydronephrosis, elevated cystanin(sic) c, or clinical symptoms	61/75 underwent stent placement, 50/61 (82%) were managed with stents successfully	16/25	14/75 underwent PCN after unsuccessful stenting, 11/61 required PCN after failure with stent management	24/50	61/75 with mean survival of 9 mo for stent and PCN cohort	Progression to PCN was noted in patients with bladder invasion and severe hydronephrosis. Multivariate analysis revealed that obstruction > 3 cm and elevated cystatin(sic) > 2.5 mg/L predicted stent failure. Stenting was less expensive and required less procedural time as compared to PCN

CT: Computed tomography; PCN: Percutaneous nephrostomy; MRI: Magnetic resonance imaging; NR: Not reported/studied; US: Ultrasonography.

with impaired quality of life.

Efficacy of PCN and ureteral stenting in malignant ureteral obstruction

In the setting of malignant obstruction, ureteral stent placement has well described technical limitations. Cystoscopic placement of ureteral stents may be technically difficult in the setting of advanced malignancy and is associated with high failure rate when extrinsic obstruction is secondary to pelvic or retroperitoneal tumors[28,29]. However, PCN requires an external collection device that often results in quality of life impairment for which some patients may initially refuse the procedure. As such, the most efficacious management of malignant ureteral obstruction has not been well established and remains controversial. In many instances, the type of urinary diversion may depend on clinician bias and expertise, procedure availability, and urgency of the diversion[30,31].

It is well reported that a percutaneous approach to malignant urinary decompression has high technical success rates[1,27,32]. When urgent relief of ureteral obstruction is the only factor in determining the modality of drainage, PCN appears to be the more reliable approach in the setting of advanced malignancy. Ku *et al*[27] reported a greater chance of progressive loss of patency after ureteral stenting compared to PCN in which the incidence of failed diversion secondary to obstruction was 11% and 1.3%, respectively. Feng *et al*[1] demonstrated initial success of stent placement in 71% of patients with pelvic malignancies with late stent failure in 41%, necessitating PCN placement with 100% success rate. In this study, 89% of cervical cancer patients failed initial stent placement and 92% ultimately required percutaneous drainage[1]. In a similar setting, Ganatra *et al*[11] reported late stent failure in more than one third of patients within 6 mo of initial stent placement. Gross tumor invasion evident at cystoscopy was a significant risk factor for stent failure with progression to PCN[11]. Song *et al*[26] reported successful management of ureteral obstruction secondary to gynecological malignancies by ureteral stenting in 67% of patients with greater trend toward PCN progression noted in patients with tumor invasion of the bladder. Other studies by Docimo *et al*[29], Cheung *et al*[33] and Yosspeowitch *et al*[34] demonstrated post-procedural stent failure rates in extrinsic malignant ureteral obstruction ranging from 42%-45%. Despite the high rate of ureteral stent failure, a difference in median survival between the two treatment modalities has not been demonstrated[26].

In general, variables such as the type and level of obstruction, renal insufficiency, degree of hydronephrosis, systemic treatment post-stenting, cystoscopic evidence of bladder invasion and length of obstruction greater than 3 cm have been found to be predictors of stent failure in the setting of malignant ureteral obstruction[11,26,33,34]. Furthermore, prostate, cervical and bladder cancers causing ureteral obstruction due to tumor invasion of the trigone have a higher primary stent failure rate compared to non-pelvic malignancies[1,20]. Therefore, primary PCN placement should be advocated in these patients. Patients with prostate cancer who underwent successful internal stent placement, however, were found to have long duration of stent function and low late failure rate[20].

In summary, PCN is an effective method of diversion in patients with ureteral obstruction secondary to advanced malignancies. This should be the primary method of decompression in patients whose tumors are visualized to involve the urinary bladder. When adequate urinary decompression has been achieved, conversion of a PCN to an antegrade stent is possible, thus eliminating the need for nephrostomy collection devices to minimize complications and improve patient independence. For patients with other pelvic or non-pelvic malignancies, retrograde ureteral stenting may be attempted. If successful, long-term drainage may be expected, however close monitoring is required for late stent failures. If stent placement is unsuccessful, percutaneous drainage remains an option and is nearly always technically successful.

PCN *VS* STENTING IN THE SETTING OF NON-MALIGNANT URETERAL OBSTRUCTION

Non-malignant causes of ureteral obstruction can be intrinsic such as stone disease, ureteral stricture or congenital ureteropelvic junction obstruction, or extrinsic such as idiopathic retroperitoneal fibrosis.

Nearly all clinicians agree that obstructing stones, with a concern for sepsis require immediate decompression of the urinary system[31]. Though large epidemiologic studies of the management of obstructed infected nephrolithiasis demonstrate higher rates of sepsis and mortality associated with PCN placement relative to ureteral stenting, the observational nature of the analysis highlights the need for prospective analyses of PCN *vs* stenting for obstructive nephrolithiasis[35]. Despite this obvious need, there are few studies comparing the efficacy of ureteral stenting *vs* PCN in the setting of obstructive urolithiasis (Table 2). The choice between PCN and stenting is often made by the urologist at initial presentation and can be influenced by factors including disease severity, stone size, location of stone, eventual modality of definitive stone management, or even availability of in-house interventional radiology services[31]. Retrospective studies reveal that both procedures have high success rates[23,36]. In the setting of unsuccessful stenting, PCN is often successful, but the contrary is not always true. Furthermore, patients are often selected for PCN over ureteral stenting in the setting of larger stones and if they are more severely ill[36,37]. Goldsmith *et al*[36] studied 130 patients who underwent decompression for obstructing ureteral stone with PCN or stent placement. Although patients who underwent PCN placement had longer hospital stay, other outcomes such as time to definitive stone management, rates of spontaneous stone passage, and initiation of stone metabolic workup were not statistically different. The authors noted that the

Table 2 Percutaneous nephrostomy *vs* retrograde stent utilization in ureteral stone disease obstruction

Ref.	Study design	Cohort	Diagnosis	Stent	Complication	Nephrostomy	Complications	Conclusions
Ahmad *et al*[23], 2013	Retrospective, 2010-2011	*n* = 300 (20/100 (stent) and 36/200 (PCN) had malignant obstruction)	NR	97/100 had successful placement, 3 proceeded to have PCN	37/97 (38%) complication rate (7 fever/sepsis, 10 bleeding/hematuria, 12 pain/irritation, 1 ureteral perforation, 2 stent migration, 5 stone encrustation	195/200 had successful PCN placement	25/195 (12.8%) complication rate (7 fever/sepsis, 9 bleeding/ hematuria, 9 dislodgement)	PCN had lower incidence of complications as compared to stenting
Goldsmith *et al*[36], 2013	Retrospective, 1995-2011	*n* = 130 patients with infected urolithiasis who underwent procedural decompression	CT and 2/4 SIRS criteria	69/71 successful stent placement, 2 proceeded to PCN	NR	58/59 successful PCN placement, 1 proceeded to retrograde stent	NR	Patients selected for PCN had larger stones and were more severely ill. Patients who underwent PCN had longer hospital stay on multivariable analysis. Time from septic event to definitive treatment, rates of spontaneous stone passage, and initiation of metabolic stone workup were the same between the two groups
Joshi *et al*[41], 2001	Prospective, non-randomized	*n* = 34 patients (22 male) with obstructing ureteral stones	X-ray, US, *IV* urography	21	NR	13	NR	Stent patients were more likely to report hematuria, dysuria, urgency as compared to PCN patients. Stent patients required analgesics more frequently than the PCN group. Patients in the PCN required more daily care as compared to stent patients. EuroQOL questionnaire revealed differences in mobility, self care, and problems with usual activity and pain between the two cohorts but no significant differences in overall QOL
Mokhmalji *et al*[38], 2001	Prospective randomized, 1996-1998	*n* = 40 patients with ureteral stone and evidence of infection	Imaging modality NR and 1 major (renal colic, fever, ston e > 15 mm, sepsis and elevated Cr > 1.7 mg/dL) or 2 minor criteria (lower UTI, wbc change, diminished patient compliance)	16/20 successfully underwent stent placement	Fluoroscopy exposure > 2 min (40%), IV analgesics (35%)	20/20 underwent initial PCN, 4/20 underwent subsequent PCN due to failed attempted stent	Fluoroscopy > 2 min (10%), IV analgesics (10%)	Time to definitive therapy was longer in stent group as compared to PCN group due to persistent signs of urinary tract infection. Unsuccessful stent placement occurred in older patients and with stones located in proximal ureter. No statistical differences in QOL but a trend to lower QOL was seen in stent patients who were male or < 40 yr
Pearle *et al*[40], 1998	Prospective randomized, 1995-1997	*n* = 42 patients with ureteral stone and evidence of infection	*IV* pyelography, US, X-ray, CT, or retrograde pyelography with WBC > 17000 mm or temperature > 38 ℃	21 underwent successful stent placement		20/21 underwent successful PCN, 1 proceeded to undergo retrograde stent placement		Fluoroscopy and procedural times shorter in stent vs PCN cohort. Higher number of positive urine cultures post-PCN was noted as compared to post-stent placement. Length of stay, blood culture positivity, and time to WBC and temperature normalization were not statistically different. Costs associated with stent placement more than twice of that of PCN. Increased back pain noted in PCN group
Yoshimura *et al*[37], 2004	Retrospective, 1994-2003	*n* = 53 (59 events) patients underwent emergency drainage with ureteral stones and SIRS criteria	NR	35 stent events	NR	24 PCN events	NR	Patients who underwent stent had smaller stones but similar rates of ICU management as compared to PCN

SIRS: Systemic inflammatory response syndrome; QOL: Quality of life; US: Ultrasound; *IV*: Intravenous; WBC: White blood cell count; NR: Not reported/studied; ESWL: Extracorporeal shock-wave lithotripsy.

method of initial decompression correlated with eventual approach selected for definitive stone management. Patients treated with PCN were more likely to undergo percutaneous definitive management, while patients managed with ureteral stenting were more likely to be treated with a ureteroscopic approach[36].

Two prospective studies comparing PCN *vs* stent management of obstructing ureteral stones have conflicting outcomes. Mokhmalji *et al*[38] in 2001 prospectively randomized 40 patients to receive either PCN or stent. Sixteen out of twenty stents were successfully placed while all twenty PCNs were successfully placed initially. All unsuccessful stents were successfully managed by PCN. Their results demonstrated that stent utilization was less successful as compared to PCN and there was a trend for longer antibiotic therapy due to persistent signs of urinary tract infection in patients who underwent stent placement. Consistent with Mokhmalji *et al*[38], a large epidemiologic survey reveals that stent failure as evidenced by the need for nephrostomy placement has been noted to be related to male gender, renal stone location, and acute kidney injury[39]. In contrast, Pearle *et al*[40] randomized 42 patients to receive PCN *vs* stents. This study failed to demonstrate one procedure to be more successful than the other[40]. All 21stents and 20 out of 21 PCNs were successfully placed. One failed PCN successfully underwent stent placement. Their results demonstrated an increased incidence of bacterial urinary colonization post-procedure in the PCN group as compared to the stent group, but overall no differences in time to clinical improvement or length of stay were noted.

In stone disease, the decision for PCN *vs* stent appears to be dictated by stone size and clinical presentation. The prospective studies looking at both procedures revealed no definitive best practice and nearly all of the studies reported on different outcomes making direct comparison impractical.

Quality of life with short-term PCN vs stent

Unlike malignant ureteral obstruction, decompression with PCN or stenting in stone disease is often short-term with eventual removal. In light of this, quality of life considerations for these patients are not necessarily the same as for those requiring long-term decompression, and should be studied in this population as well. Joshi *et al*[41] prospectively surveyed 21 stent and 13 PCN patients using the EuroQol, a validated general quality of life questionnaire, as well as procedure specific questions focusing on symptoms in three categories - dysuria, pain, and daily care. Patients were surveyed by a single interviewer on the day of definitive therapy. Patients who had stents were more likely to require analgesic medications and reported urinary symptoms such as dysuria, hematuria, and urgency. PCN patients required more daily care of nephrostomy, but overall there were no statistically significant differences in utility scores calculated from the five EuroQol domains encompassing mobility, self-care, usual activity, pain/discomfort, and anxiety/depression. Mokhmolji *et al*[38] confirmed that there were no statistically significant differences between the two procedures in terms of general well-being and state of mind when assessing patients who underwent stent *vs* nephrostomy immediately post-operatively and 2-4 wk subsequently[38]. These studies suggest that both stents and PCN decrease the quality of life and although patients did not prefer one procedure over the other, they should be made aware of potential discomforts associated with each procedure given the options.

PCN vs ureteral stent for idiopathic retroperitoneal fibrosis

Idiopathic retroperitoneal fibrosis is a rare disease of unknown etiology and is characterized by chronic inflammation within the retroperitoneum resulting in ureteral obstruction in up to 50% of cases[42-45]. Mertens *et al*[46] conducted a retrospective study of 30 patients with idiopathic retroperitoneal fibrosis involving 44 renal units from January 2002 to April 2010 with a median nephrostomy or stent dwelling time of 9.3 mo. PCN was placed as the first intervention in 27% of the entire cohort (12/44), and ultimately the majority of these patients (9/12) received subsequent ureteral stent placement[46]. In contrast, the majority of renal units (32/44) initially underwent attempted stent placement, which was successfully initiated in 79% (25/32) and successfully maintained in 80% (20/25). The authors found that the overall rate of complication (obstruction, dislodgment, bleeding requiring transfusion, acute pyelonephritis, and urosepsis) was similar for both cohorts (PCN 21% *vs* stent 17.9%; $P = 0.79$). Ultimately, the investigators concluded that both stents and PCN were safe methods of urinary tract drainage with similar complication profiles. Complementary advantages were noted and the authors concluded that both methods of drainage may be utilized given the relapsing/remitting course of disease[46].

CLINICIAN PREFERENCES FOR PCN *VS* URETERAL STENTING

Patient choice is heavily influenced by physician recommendations[47], and as there are no clinical guidelines and little published evidence directing the use of PCN *vs* ureteral stenting, physicians often rely on their personal experience and preference in advising their patients. Further, patients may receive conflicting advice from various providers, as the clinician advising intervention is often not the clinician who also performs the intervention (medical oncologist *vs* urologist *vs* interventional radiologist).

In 2006, Lynch *et al*[31] conducted a postal survey amongst 153 radiologists and 132 urologists residing in the United Kingdom to determine current opinion regarding utilization of PCN *vs* ureteral stent for acute renal obstruction. Despite a meager response rate of 19.3% (18.3% of radiologists and 19.3% of urologists), the authors demonstrated 90%-100% consensus for urinary

tract decompression for the clinical scenarios of "clinical sepsis" and "elevated creatinine and potassium", while only 50% of clinicians felt unobstruction was indicated in the scenario of "ureteral obstruction with hydronephrosis with advanced malignancy for palliation[31]. Additionally, clinicians disagreed on the method of decompression with urologists favoring PCN over ureteral stent placement more often than radiologists for all clinical scenarios (74% *vs* 49%; median preference rate urologist *vs* radiologist) other than patients with "uncomplicated benign disease" and in those patients with "coagulopathy". The authors speculated that the results were driven by logistical (availability of operating rooms and anesthesia) and patient factors (evidence of pelvic malignancy, radiotherapy, chronic upper tract stricture) rather than financial motives, given the absence of monetary incentives to providing care in the United Kingdom health system[31].

Similarly, Hyams *et al*[30] sought to compare intervention preferences for malignant external ureteral obstruction utilizing a web-based survey sent to 3000 American clinicians (1500 urologists and 1500 medical oncologists). While only 15% of urologists and 12.4% of medical oncologists responded, there was significant disagreement between urologists and medical oncologists in regards to management of hypothetical clinical scenarios. For example, oncologists were more likely to recommend PCN as the next option after stent failure in unilateral obstruction (79% *vs* 62%, $P < 0.0001$), where as urologists were more likely to suggest stent manipulation including upsizing, stent exchange, internalizing, *etc.,* (37% *vs* 17%). Further, perception of complication varied between both groups. Urologists reported the greatest risk of dislodged PCN (48% *vs* 18%, $P < 0.0001$), while medical oncologists primarily feared infection (40% *vs* 8%). In regards to indwelling ureteral stents, urologists were most concerned about the negative impact on quality of life (65% *vs* 13%, $P < 0.0001$) while oncologists were again primarily concerned with risk of infection (43% *vs* 3%). Of note, both urologists and oncologists agreed that indwelling ureteral stents afford greater comfort (87% *vs* 93%, $P = 0.07$) and quality of life (95% *vs* 93%, $P = 0.46$)[30]. Taken together, both studies indicate consensus amongst clinicians for urinary tract unobstruction in certain clinical scenarios (sepsis and AKI), yet significant divergence of opinion in other scenarios (malignant external ureteral obstruction). Additionally, the preference of PCN *vs* ureteral stenting varies both by clinician specialty and nationality[30,31]. Both groups of investigators advocate for additional prospective studies, clinical guidelines, and ultimately increased communication between specialists[30,31].

CONCLUSION

This review sought to find consensus on the use of PCN *vs* stents in the treatment of ureteral obstruction. There were no prospective studies that compared PCN *vs* stent utilization in the management of malignant ureteral obstruction. Of the retrospective studies reviewed, the majority could not find a difference in complication rates or quality of life between the two procedures. Due to the retrospective nature of the studies, success rates could not be effectively compared between the two methods as patient selection for either procedure was based often on clinician and/or patient preference. In summary, most authors recommended stent utilization as a first step if possible and nephrostomy drainage if there is concern for difficulty in retrograde access of the ureters, or in the setting requiring immediate relief of kidney dysfunction. This area would certainly benefit from additional prospective studies as often the reasoning behind initial ureteral stent placement is driven by clinician preference arising from the belief that ureteral stents provide a decreased risk of infection and increased quality of life despite studies citing no statistical differences in these areas[19,27].

Both retrospective and prospective studies were reviewed for management of obstruction due to stone disease. The retrospective studies were of heterogeneous quality demonstrating significant differences in stone size between patients who underwent PCN and stent placement. The prospective studies revealed that overall quality of life was similar although with different bothersome aspects in each of the two groups. Overall, stent utilization tended to require more analgesia as compared to PCN. The available studies revealed conflicting results on rates of infection between the two procedures, as well as time to definitive therapy, and length of hospital stay.

Although PCN and stent utilization appear to be mostly clinician-driven, certain patterns of practice are notable. Most clinicians prefer stent utilization due to presumed benefits associated with decreased rates of infection and improved patient comfort, while PCN utilization is noted for more definitive efficacy of urinary drainage. This review has revealed multiple studies showing either no difference or conflicting evidence regarding infection rates and we urge clinicians to be aware of this lack of clear superiority of ureteral stenting over PCN. Finally, given that quality of life studies have not demonstrated a clear superiority of ureteral stenting over PCN, when long term PCN and stent management is being considered, the patient should be centrally involved in the discussion, and the decision for either procedure will need to be agreed upon mutually.

REFERENCES

1 **Feng MI**, Bellman GC, Shapiro CE. Management of ureteral obstruction secondary to pelvic malignancies. *J Endourol* 1999; **13**: 521-524 [PMID: 10569528]
2 **Sharer W**, Grayhack JT, Graham J. Palliative urinary diversion for malignant ureteral obstruction. *J Urol* 1978; **120**: 162-164 [PMID: 78993]
3 **Holden S**, McPhee M, Grabstald H. The rationale of urinary diversion in cancer patients. *J Urol* 1979; **121**: 19-21 [PMID: 83395]
4 **Fiuk J**, Bao Y, Calleary JG, Schwartz BF, Denstedt JD. The use of internal stents in chronic ureteral obstruction. *J Urol* 2015; **193**: 1092-1100 [PMID: 25463984 DOI: 10.1016/j.juro.2014.10.123]

5 **Bansal T**, Mehrotra P, Jayasena D, Okolo S, Yoong W, Govind A. Obstructive nephropathy and chronic kidney disease secondary to uterine leiomyomas. *Arch Gynecol Obstet* 2009; **279**: 785-788 [PMID: 18818940 DOI: 10.1007/s00404-008-0769-2]

6 **Fletcher HM**, Wharfe G, Williams NP, Gordon-Strachan G, Johnson P. Renal impairment as a complication of uterine fibroids: a retrospective hospital-based study. *J Obstet Gynaecol* 2013; **33**: 394-398 [PMID: 23654324 DOI: 10.3109/01443615.2012.753421]

7 **Ormond JK**. Idiopathic retroperitoneal fibrosis: an established clinical entity. *JAMA* 1960; **174**: 1561-1568 [PMID: 13731250]

8 **Tan BJ**, Rastinehad AR, Marcovich R, Smith AD, Lee BR. Trends in ureteropelvic junction obstruction management among urologists in the United States. *Urology* 2005; **65**: 260-264 [PMID: 15708034 DOI: 10.1016/j.urology.2004.09.051]

9 **McIntyre JF**, Eifel PJ, Levenback C, Oswald MJ. Ureteral stricture as a late complication of radiotherapy for stage IB carcinoma of the uterine cervix. *Cancer* 1995; **75**: 836-843 [PMID: 7828135]

10 **Montana GS**, Fowler WC. Carcinoma of the cervix: analysis of bladder and rectal radiation dose and complications. *Int J Radiat Oncol Biol Phys* 1989; **16**: 95-100 [PMID: 2912959]

11 **Ganatra AM**, Loughlin KR. The management of malignant ureteral obstruction treated with ureteral stents. *J Urol* 2005; **174**: 2125-2128 [PMID: 16280741 DOI: 10.1097/01.ju.0000181807.56114.b7]

12 **Donat SM**, Russo P. Ureteral decompression in advanced non-urologic malignancies. *Ann Surg Oncol* 1996; **3**: 393-399 [PMID: 8790853]

13 **Fallon B**, Olney L, Culp DA. Nephrostomy in cancer patients: to do or not to do? *Br J Urol* 1980; **52**: 237-242 [PMID: 7426987]

14 **Chung PH**, Krabbe LM, Darwish OM, Westerman ME, Bagrodia A, Gayed BA, Haddad AQ, Kapur P, Sagalowsky AI, Lotan Y, Margulis V. Degree of hydronephrosis predicts adverse pathological features and worse oncologic outcomes in patients with high-grade urothelial carcinoma of the upper urinary tract. *Urol Oncol* 2014; **32**: 981-988 [PMID: 25022858 DOI: 10.1016/j.urolonc.2014.02.018]

15 **Pradhan TS**, Duan H, Katsoulakis E, Salame G, Lee YC, Abulafia O. Hydronephrosis as a prognostic indicator of survival in advanced cervix cancer. *Int J Gynecol Cancer* 2011; **21**: 1091-1096 [PMID: 21738045 DOI: 10.1097/IGC.0b013e31821cabc8]

16 **Lapitan MC**, Buckley BS. Impact of palliative urinary diversion by percutaneous nephrostomy drainage and ureteral stenting among patients with advanced cervical cancer and obstructive uropathy: a prospective cohort. *J Obstet Gynaecol Res* 2011; **37**: 1061-1070 [PMID: 21481096 DOI: 10.1111/j.1447-0756.2010.01486.x]

17 **Cordeiro MD**, Coelho RF, Chade DC, Pessoa RR, Chaib MS, Colombo-Junior JR, Pontes-Junior J, Guglielmetti GB, Srougi M. A prognostic model for survival after palliative urinary diversion for malignant ureteric obstruction: a prospective study of 208 patients. *BJU Int* 2016; **117**: 266-271 [PMID: 25327474 DOI: 10.1111/bju.12963]

18 **Ishioka J**, Kageyama Y, Inoue M, Higashi Y, Kihara K. Prognostic model for predicting survival after palliative urinary diversion for ureteral obstruction: analysis of 140 cases. *J Urol* 2008; **180**: 618-621; discussion 621 [PMID: 18554655 DOI: 10.1016/j.juro.2008.04.011]

19 **Monsky WL**, Molloy C, Jin B, Nolan T, Fernando D, Loh S, Li CS. Quality-of-life assessment after palliative interventions to manage malignant ureteral obstruction. *Cardiovasc Intervent Radiol* 2013; **36**: 1355-1363 [PMID: 23404519 DOI: 10.1007/s00270-013-0571-9]

20 **Shekarriz B**, Shekarriz H, Upadhyay J, Banerjee M, Becker H, Pontes JE, Wood DP. Outcome of palliative urinary diversion in the treatment of advanced malignancies. *Cancer* 1999; **85**: 998-1003 [PMID: 10091780]

21 **Giannarini G**, Keeley FX, Valent F, Manassero F, Mogorovich A, Autorino R, Selli C. Predictors of morbidity in patients with indwelling ureteric stents: results of a prospective study using the validated Ureteric Stent Symptoms Questionnaire. *BJU Int* 2011; **107**: 648-654 [PMID: 20590539 DOI: 10.1111/j.1464-410X.2010.09482.x]

22 **Hausegger KA**, Portugaller HR. Percutaneous nephrostomy and antegrade ureteral stenting: technique-indications-complications. *Eur Radiol* 2006; **16**: 2016-2030 [PMID: 16547709 DOI: 10.1007/s00330-005-0136-7]

23 **Ahmad I**, Saeed Pansota M, Tariq M, Shahzad Saleem M, Ali Tabassum S, Hussain A. Comparison between Double J (DJ) Ureteral Stenting and Percutaneous Nephrostomy (PCN) in Obstructive Uropathy. *Pak J Med Sci* 2013; **29**: 725-729 [PMID: 24353616]

24 **Richter S**, Ringel A, Shalev M, Nissenkorn I. The indwelling ureteric stent: a 'friendly' procedure with unfriendly high morbidity. *BJU Int* 2000; **85**: 408-411 [PMID: 10691815]

25 **Farrell TA**, Hicks ME. A review of radiologically guided percutaneous nephrostomies in 303 patients. *J Vasc Interv Radiol* 1997; **8**: 769-774 [PMID: 9314366]

26 **Song Y**, Fei X, Song Y. Percutaneous nephrostomy versus indwelling ureteral stent in the management of gynecological malignancies. *Int J Gynecol Cancer* 2012; **22**: 697-702 [PMID: 22315095 DOI: 10.1097/IGC.0b013e318243b475]

27 **Ku JH**, Lee SW, Jeon HG, Kim HH, Oh SJ. Percutaneous nephrostomy versus indwelling ureteral stents in the management of extrinsic ureteral obstruction in advanced malignancies: are there differences? *Urology* 2004; **64**: 895-899 [PMID: 15533473 DOI: 10.1016/j.urology.2004.06.029]

28 **Chitale SV**, Scott-Barrett S, Ho ET, Burgess NA. The management of ureteric obstruction secondary to malignant pelvic disease. *Clin Radiol* 2002; **57**: 1118-1121 [PMID: 12475538]

29 **Docimo SG**, Dewolf WC. High failure rate of indwelling ureteral stents in patients with extrinsic obstruction: experience at 2 institutions. *J Urol* 1989; **142**: 277-279 [PMID: 2746744]

30 **Hyams ES**, Shah O. Malignant extrinsic ureteral obstruction: a survey of urologists and medical oncologists regarding treatment patterns and preferences. *Urology* 2008; **72**: 51-56 [PMID: 18372019 DOI: 10.1016/j.urology.2008.01.046]

31 **Lynch MF**, Anson KM, Patel U. Current opinion amongst radiologists and urologists in the UK on percutaneous nephrostomy and ureteric stent insertion for acute renal unobstruction: Results of a postal survey. *BJU Int* 2006; **98**: 1143-1144 [PMID: 17125470 DOI: 10.1111/j.1464-410X.2006.06513.x]

32 **Hyppolite JC**, Daniels ID, Friedman EA. Obstructive uropathy in gynecologic malignancy. Detrimental effect of intraureteral stent placement and value of percutaneous nephrostomy. *ASAIO J* 1995; **41**: M318-M323 [PMID: 8573816]

33 **Chung SY**, Stein RJ, Landsittel D, Davies BJ, Cuellar DC, Hrebinko RL, Tarin T, Averch TD. 15-year experience with the management of extrinsic ureteral obstruction with indwelling ureteral stents. *J Urol* 2004; **172**: 592-595 [PMID: 15247739 DOI: 10.1097/01.ju.0000130510.28768.f5]

34 **Yossepowitch O**, Lifshitz DA, Dekel Y, Gross M, Keidar DM, Neuman M, Livne PM, Baniel J. Predicting the success of retrograde stenting for managing ureteral obstruction. *J Urol* 2001; **166**: 1746-1749 [PMID: 11586215]

35 **Sammon JD**, Ghani KR, Karakiewicz PI, Bhojani N, Ravi P, Sun M, Sukumar S, Trinh VQ, Kowalczyk KJ, Kim SP, Peabody JO, Menon M, Trinh QD. Temporal trends, practice patterns, and treatment outcomes for infected upper urinary tract stones in the United States. *Eur Urol* 2013; **64**: 85-92 [PMID: 23031677 DOI: 10.1016/j.eururo.2012.09.035]

36 **Goldsmith ZG**, Oredein-McCoy O, Gerber L, Bañez LL, Sopko DR, Miller MJ, Preminger GM, Lipkin ME. Emergent ureteric stent vs percutaneous nephrostomy for obstructive urolithiasis with sepsis: patterns of use and outcomes from a 15-year experience. *BJU Int* 2013; **112**: E122-E128 [PMID: 23795789 DOI: 10.1111/bju.12161]

37 **Yoshimura K**, Utsunomiya N, Ichioka K, Ueda N, Matsui Y, Terai A. Emergency drainage for urosepsis associated with upper urinary tract calculi. *J Urol* 2005; **173**: 458-462 [PMID: 15643207 DOI: 10.1097/01.ju.0000150512.40102.bb]

38 **Mokhmalji H**, Braun PM, Martinez Portillo FJ, Siegsmund M, Alken P, Köhrmann KU. Percutaneous nephrostomy versus ureteral stents for diversion of hydronephrosis caused by stones: a

prospective, randomized clinical trial. *J Urol* 2001; **165**: 1088-1092 [PMID: 11257644]

39 **Varda B**, Sood A, Krishna N, Gandaglia G, Sammon JD, Zade J, Schmid M, Zorn KC, Trinh QD, Bhojani N. National rates and risk factors for stent failure after successful insertion in patients with obstructed, infected upper tract stones. *Can Urol Assoc J* 2015; **9**: E164-E171 [PMID: 26085874 DOI: 10.5489/cuaj.2456]

40 **Pearle MS**, Pierce HL, Miller GL, Summa JA, Mutz JM, Petty BA, Roehrborn CG, Kryger JV, Nakada SY. Optimal method of urgent decompression of the collecting system for obstruction and infection due to ureteral calculi. *J Urol* 1998; **160**: 1260-1264 [PMID: 9751331]

41 **Joshi HB**, Adams S, Obadeyi OO, Rao PN. Nephrostomy tube or 'JJ' ureteric stent in ureteric obstruction: assessment of patient perspectives using quality-of-life survey and utility analysis. *Eur Urol* 2001; **39**: 695-701 [PMID: 11464060]

42 **Scheel PJ**, Feeley N. Retroperitoneal fibrosis: the clinical, laboratory, and radiographic presentation. *Medicine* (Baltimore) 2009; **88**: 202-207 [PMID: 19593224 DOI: 10.1097/MD.0b013e3181afc439]

43 **Vaglio A**, Salvarani C, Buzio C. Retroperitoneal fibrosis. *Lancet* 2006; **367**: 241-251 [PMID: 16427494 DOI: 10.1016/s0140-6736(06)68035-5]

44 **van Bommel EF**. Retroperitoneal fibrosis. *Neth J Med* 2002; **60**: 231-242 [PMID: 12365466]

45 **van Bommel EF**, Jansen I, Hendriksz TR, Aarnoudse AL. Idiopathic retroperitoneal fibrosis: prospective evaluation of incidence and clinicoradiologic presentation. *Medicine* (Baltimore) 2009; **88**: 193-201 [PMID: 19593223 DOI: 10.1097/MD.0b013e3181afc420]

46 **Mertens S**, Zeegers AG, Wertheimer PA, Hendriksz TR, van Bommel EF. Efficacy and complications of urinary drainage procedures in idiopathic retroperitoneal fibrosis complicated by extrinsic ureteral obstruction. *Int J Urol* 2014; **21**: 283-288 [PMID: 24033464 DOI: 10.1111/iju.12234]

47 **Pucheril D**, Dalela D, Sammon J, Sood A, Sun M, Trinh QD, Menon M, Abdollah F. The influence of physician recommendation on prostate-specific antigen screening. *Urol Oncol* 2015; **33**: 424.e1-424.e7 [PMID: 26206103 DOI: 10.1016/j.urolonc.2015.06.013]

48 **Kanou T**, Fujiyama C, Nishimura K, Tokuda Y, Uozumi J, Masaki Z. Management of extrinsic malignant ureteral obstruction with urinary diversion. *Int J Urol* 2007; **14**: 689-692 [PMID: 17681056 DOI: 10.1111/j.1442-2042.2007.01747.x]

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