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Long-Term Results after Acute Therapy of Obstructive Pyelonephritis

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Key Words
Urinary tract infection · Renal obstruction · Obstructive pyelonephritis · Pyonephrosis · Percutaneous nephrostomy · Long-term results

Abstract
Introduction: To evaluate therapeutic results till 5 years after therapy of obstructive pyelonephritis (OPN) emphasizing regular follow-up. ***Material and Methods:*** During 5 years, 57 patients with OPN were treated. The patients' charts were reviewed retrospectively for clinical data. These were completed by a questionnaire. ***Results:*** In the group of 57 patients (average age 56 years), about two third were women. Urolithiasis (65%) and tumors (21%) were the main causes of obstruction; fever (91%) and loin pain (86%) the main symptoms. Three fourth of the patients showed renal insufficiency and nearly 50% anemia. *E. coli* and *Proteus* spp. were the dominating organisms. Sonography detected obstruction in 93% cases. In one third of cases, CT scan was added; 81% percutaneous nephrostomy and 19% ureteral stenting were the initial methods of urinary drainage. During therapy, 23% nephrectomies (19% complete, 4% partial) were performed. Long-term follow-up showed 11% recurrent OPN and 33% recurrent UTI. ***Conclusions:*** After diagnosis of OPN, primary nephrostomy or ureteral stenting and antibiotic therapy are the first measures. If recurrent urinary tract infections or OPN occur, long-term follow-up and low-dose antibiotic prophylaxis may be discussed.

Introduction

Renal obstruction arises most often from urolithiasis, tumors, pregnancy, scars after infection or trauma, congenital anomalies, or operations. End-stage renal obstruction with loss of parenchyma but without infection is termed hydronephrosis [1]. An infection in an obstructed kidney is a severe form of complicated urinary tract infection (UTI). After loosing renal function and parenchyma, an infected and obstructed kidney may be termed 'pyonephrosis', if there is pus within the dilated collecting system ('pus under pressure') [2, 3]. The transition between the two forms might be gradual. All infections in obstructed kidneys should be considered complicated pyelonephritis with obstruction or obstructive pyelonephritis (OPN).

The main causative bacteria in OPN are E. coli, Proteus, Klebsiella, or Pseudomonas species [4–7]. After sampling for bacteriological cultures, empiric antibiotic therapy needs to be started immediately, and resolving

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Table 1. Causes of obstruction in 57 patients with obstructive pyelonephritis (OPN) or pyonephrosis

Causes	Number	Percentage
Urolithiasis	37	65
Pelvic and retroperitoneal tumors	12	21
Pregnancy	3	5
Iatrogenic lesions	2	4
Malformation	2	4
Neurogenic bladder after apoplex	1	2

Table 2. Clinical symptoms in 57 patients with obstructive pyelonephritis (OPN) or pyonephrosis

Symptoms	Number	Percentage
Fever	52	91
Flank pain	49	86
Nocturia	18	32
Dysuria	11	19
Macrohematuria	9	16
Frequency	8	14

the obstruction under antibiotic therapy is mandatory [3, 5, 7].

Long-term follow-up data after antibiotic therapy and relief of renal obstruction of OPN are widely missing for adults.

Materials and Methods

The data of all patients with OPN at the Department of Urology, University of Munich, needing inpatient treatment and urinary diversion due to clinical signs, symptoms, and findings during a period of 5 years were analyzed retrospectively by reviewing the intervention charts for nephrostomy and ureteral stenting. Patients with manifest urosepticemia at admission were ruled out. History, symptoms, laboratory values, imaging results, and therapy were included in the review.

These data were supplemented by a questionnaire sent to the family doctor 1–5 years after the hospital stay. All patients agreed to participate in the study.

Results

During a period of 5 years, 57 patients (38 women – 67%, 19 men – 33%) with OPN were identified. The average age was 56 (range 9–86) (52.0 in women, 64.0 in men), and 2/3 were women. The causes of obstruction are shown in table 1. The average age for patients with OPN due to urolithiasis (n = 37, 65%), the most common cause was 56.6 years and with tumors of the pelvic and retroperitoneal region (n = 12, 21%), the second most common cause was 65.4 years.

One iatrogenic renal obstruction resulted from double J stenting after iatrogenic ureter lesion. The other occurred as a recurrence after Anderson-Hynes pyeloplasty. One malformation was an obstructed and deformed single kidney, and the other was an obstructed renal duplication.

The main symptoms were fever (91%) and loin pain (86%) (for details, see table 2). Fifty-three out of fifty-seven patients (93%) showed renal beds sensitive to percussion, whereas one (2%) showed a palpable flank tumor.

As expected, leucocytosis was the predominant laboratory deviation, whereas accelerated blood sedimentation rate occurred in only 16%. CRP and procalcitonine were not estimated regularly and are therefore not included.

Overall, 75% had an increased serum creatinine above 1.0 mg/dl and nearly 50% had anemia (hemoglobin in women <12 g/dl and in men <14 g/dl). Most patients' urine showed leucocyturia suspicious for UTI (for details, see table 3).

Results of bacterial cultures from bladder or renal pelvis urine (sampled by ureter catheter or renal punction) or intraoperatively taken by swabs are shown in table 3. The main infecting agents were *E. coli* and Proteus. Routine anaerobic cultures were not done.

Sonography was the imaging method of first choice. Fifty-three out of fifty-seven obstructed kidneys (93%) were detected correctly (for details, see table 3). In 2 out of the 57 (4%) OPN patients with nephrolithiasis, a tumor was suspected as a result of sonography and in 2 out of 57 patients with staghorn calculus (4%), obstruction was not recognized. In 24 patients with suspected nephrolithiasis and in 1 with suspected pelvic tumor a plain radiograph was performed. Eighteen out of 24 stones (75%) could be found with this method. In 1/3 (n = 19) cases, sonography was supplemented by CT scans without contrast media. These detected 16/19 (84%) renal obstruction cases, 10/10 (100%) tumors, and 8/9 (89%) urolithiasis.

The family doctors' initial diagnosis was correct as OPN in 34/57 cases (60%), ambiguous in 11/57 cases (19%), and wrong in 12/57 cases (21%) as confirmed during inpatient investigation. The infection in 8/57 (14%) with ambiguous or wrong initial diagnosis and the obstruction in 20/57 (35%) were not diagnosed by the family doctor. In 1/57 (2%) with OPN, the family doctor wrongly suspected a tumor.

Table 3. Laboratory changes, bacterial spectrum and imaging methods in 57 patients with obstructive pyelonephritis (OPN) or pyonephrosis

a Laboratory changes

Laboratory findings	Percentage	Number
Leukocytosis	81	46
Increased blood sedimentation rate	16	9
Increased creatinine	75	43
Increased urea	26	15
Anemia	49	28
Leukocyturia	91	52
Erythrocyturia	88	50
Proteinuria	14	8

b Bacterial spectrum

Species	Bladder urine culture	RENAL pelvis urine/ intraoperative swab
E. coli	29 (51)	27 (47)
Proteus spp.	12 (21)	9 (16)
Staphylococcus spp.	8 (14)	7 (12)
Enterococcus faecalis	11 (19)	8 (14)
Streptococcus spp.	3 (5)	1 (2)
Klebsiella pneumoniae	3 (5)	4 (7)
Corynebacterium spp.	2 (4)	3 (5)
Citrobacter freundii	1 (2)	2 (2)
Pseudomonas aeruginosa	1 (2)	3 (5)
Morganella morganii	1 (2)	0 (0)
Mixed infection	16 (28)	9 (16)
Sterile	6 (11)	5 (9)

c Imaging

Procedure	Diagnosis correct	Diagnosis ambiguous	Diagnosis wrong	Not done
Sonography	53 (93) obstruction	2 (4) with staghorn calculus	2 (4) hypoechoic tumor	0
Plain abdomen radiograph	18 (72) urolithiasis 1 (4) no urolithiasis	0	6 (24) normal	32
Intravenous-urography	27 (84) obstruction or renal insufficiency	1 (3) inactive kidney	4 (13) normal	25
Retrograde ureteropyelography	9 (100) obstruction	0	0	48
Computertomography	16 (84) OPN	3 (16) 1 semiliquid tumor, 2 lymphnodes or metastasis due to carcinoma	0	38

Figures in parentheses indicate percentages.

Antibiotic Therapy

Twenty-five patients with OPN (44%) received antibiotic monotherapy (β-lactam antibiotics 21%, fluorquinolones 19%, co-trimoxazole 2%, aminoglycosides 2%); in 32, (56%) combination therapy was used (aminoglycoside and β-lactam antibiotic 46%; fluoroquinolone and β-lactam antibiotic 5%; two β-lactam antibiotics 3%; aminoglycoside and tetracyclines 2%).

Invasive Therapy

After the start of empiric antibiotic therapy, relief of renal obstruction and removal of infectious material were followed if necessary. Initial drainage was by percutaneous nephrostomy (81%) or ureteric stenting (19%) (for details, see table 4). Eleven patients (19%) underwent nephrectomy (8/37 with nephrolithiasis, 3/12 with tumors).

In one patient with double kidney and ectopic ureter, heminephrectomy solved the problem. In one patient with a kidney stone and partial necrosis upper pole, partial nephrectomy was performed.

Follow-Up

During a follow-up of 1 to 5 years after successful OPN therapy, 18/57 patients (32%) showed recurrent UTI. In 6/57 patients (11%), OPN recurred. Eight out of fifty-seven patients (14%) died of the initially discovered tumor (8/12 – 67% of all patients with tumor), and 1 patient (2%) died of bronchopneumonia after 7 months. No fistula formation was reported. Follow-up of laboratory values was not done. Altogether, in this group of patients with OPN and without manifest urosepticemia at initial visit, no patient died due to OPN during a follow-up of 1–5 years.

Table 4. Invasive therapy in 57 patients with obstructive pyelonephritis (OPN) or pyonephrosis

Procedure	Number	Percentage
Percutaneous nephrostomy	46	81
Ureteral stenting	11	19
Nephrectomy (8/37 with nephrolithiasis, 3/12 with tumors)	11	19
Partial nephrectomy	2	4
ESWL with nephrolithiasis	19	33
Ureterorenoscopy for urolithiasis	8	14
Chemolitholysis for uric acid stones	4	7
Percutaneous litholapaxy for urolithiasis	3	5
Zeiss sling for ureteral stone	3	5
Spontaneous passage of calculus	2	4

Several procedures in one patient possible.

Discussion

General Considerations

In general, men account only for 10–20% of all patients with UTI. The relative high occurrence rate of men (33%) with OPN in this study resulted from a high rate of urolithiasis as underlying cause (37/57 – 65%). Men showed a higher stone incidence (from 1.3 up to 2.0) than did women [8, 9].

Complicated upper urinary tract infections may occur in:

(1) patients with no uropathic risk factors such as diabetes mellitus, postmenopause, renal insufficiency, or after renal transplantation;

(2) patients with uropathies (anatomical or functional obstruction or foreign bodies in the urinary tract), which can be cured or improved (e.g., ureteral stents, temporary bladder catheter, vesicorenal reflux, or state after urological intervention);

(3) patients with permanent uropathies such as permanent catheter, stent or urinary diversion, or permanent neurogenic bladder dysfunction.

Patients in groups 2 and 3 are at risk for OPN. In our group, we did not find papillary necrosis, blood clots or fungus ball, tumor obstruction of the upper urinary tract, radiation therapy, bilharziosis, or tuberculosis as further causes of endoluminal OPN or tumor compression of the upper urinary tract and M. Ormond as further causes of extrinsic OPN mentioned in the literature [10, 11].

Symptoms and Clinical Signs

In immunocompromised patients, symptoms and clinical signs of OPN may be missing and only laboratory as well as sonographic findings will give the correct diagnosis. In 5.9–12.5%, bacteriuria may be missing due to completely obstructed ureter as in 9% of renal pelvic urine cultures and in 11% of bladder urine cultures in our patients [7].

Tumors

OPN due to tumors, for example, in the pelvic region or bladder cancer, indicates locally advanced tumor state in many cases [12]. This explains the high mortality rate (8/12 – 67%) in our patients with tumor-induced OPN during follow-up.

Diagnostic Methods

Aspirates from the obstructed kidney should be sent for culture and sensitivity analysis even after antibiotic therapy has started because of frequent discrepancy between urine and aspirate results due to the slow-rising antibiotic level within intrapelvic pus [4, 11]. Compared with the lower value in our series (9%), Christoph et al. [13] reported 46% sterile pelvic urine culture, presumably because of a higher rate of antibiotic pretreatment. The relatively low rate of *E. coli* in our series is characteristic for complicated UTI, and the relatively high rate of *Proteus* spp. is due to the high rate of infection stones, which was similar in the study of Ng et al. [11]. The more difficult to treat bacteria such as Pseudomonas aeruginosa or even rarities such as Salmonella typhi may cause treatment failure in primary calculated antibiotic therapy of OPN [14, 15]. We agree with van Nieuwkoop et al. [16] that imaging is necessary in patients with febrile UTI in the presence of a history of urolithiasis and/or a urine pH ≥7.0 and/or renal insufficiency (estimated glomerular filtration rate ≤40 ml/min/1.73 m^3).

Sonography in OPN may easily show dilation of the pelvicalyceal system. After changing the patient's position, there might be a change of the border fluid level between urine and pus, echogenic material in the whole pyelocaliceal system, or gas with typical ultrasound shadows (also found in urinary stones). Thickening of the walls of the renal pelvis is another possible sign. An abnormal nephrogram with bulging of the renal contour in the setting of hydronephrosis is also suggestive of the diagnosis. A normal sonography does not completely rule out renal obstruction, especially not in an early state. Bacterial toxins may lead to calycopyelectasis without anatomical obstruction. Associated structures in the abdomen and pelvis can be imaged, which may reveal the cause or level of the obstruction [2, 4, 5, 10, 17].

An i.v. urography is recommended only if CT scan is not available and may show reduced inflow of contrast media or a silent kidney. Care has to be taken not to give contrast media in renal insufficiency patients.

During retrograde ureteropyelography after starting the antibiotic therapy, renal obstruction might be confirmed and resolved by double J stenting during one session [5].

CT is the investigation of choice in OPN not clearly diagnosed with sonography, as it depicts hydronephrosis and often the underlying cause [4, 18]. Contrast-enhanced CT scan is more desirable, as parenchymal and functional changes due to infection can be assessed. CT scan confirms till 97% of ureteral or renal stones and 100% of tumors [4, 5, 17]. The same signs of OPN than in sonography might be demonstrated with a higher sensitivity [4, 10]. Pelvic wall thickening has a sensitivity of 76% for pyonephrosis. Gas in the collecting system, in the absence of instrumentation, is the most accurate indicator of presence of infected fluid. Parenchymal or pararenal gas would be signs of concomitant emphysematous pyelonephritis in OPN [19]. Besides these findings, a striated nephrogram in the renal parenchyma as specific CT findings can occur in both pyonephrosis and obstructive pyelonephritis, although in pyonephrosis changes should be more severe. Contrast layer inversion representing contrast material overlying purulent fluid is rarely encountered [4, 17].

Therapy

After starting empiric antibiotic therapy, relief of renal obstruction should be initiated immediately by either ureteral stenting or nephrostomy [18]. Decompression of the system increases renal plasma flow and delivery of antibiotics to both parenchyma and urine [4]. Both methods are equally effective [20–22]. Nephrostomy eases controlling of urinary output and also pus may be extracted from the renal pelvis by large volume nephrostomy much more easier than via a ureteral stent. Ureteral stenting often needs to be performed in the operating room under general anesthesia, whereas nephrostomy can be performed under local anesthesia. Furthermore, there is the risk of perforating the ureter with stenting. In addition, bacteremia and septicemia may flare up under the pressure of the irrigation fluid. Nephrostomy cultures provide a higher microbiological detection rate than bladder urine cultures. Therefore, nephrostomy was used much more often in our study. A delay in renal decompression or omitting it completely will increase the rate of sepsis and mortality [2–4, 11, 23, 24].

After relief of renal obstruction, exacerbation of septicemia may occur. In our series, since we had ruled out septicemia cases at the time of admission, we did not notice this phenomenon [5, 24].

After initial therapy and stabilization of the patient, definitive relief of renal obstruction (81% in our series) or nephrectomy of the kidneys without residual function (19% in our series) are indicated [4]. Selected patients at a tertiary university center may explain the relatively low rate of 19% nephrectomies (11/57; 3/12 with malignancies, 8/37 with Urolithiasis) in our series. This rate is similar to the 12% nephrectomy rate reported by Ng et al. and a significant improvement from earlier studies, where the nephrectomy rates ranged from 35 to 88% [11].

Follow-Up

Early intervention in patients with OPN without signs of manifest urosepticemia prevented death due to the infection in our series. Ng et al. reported a 2% death rate [11].

Conclusions

Our data are the first showing a high OPN recurrence rate in adults with 11% and a high rate of UTI of 32% during long-term follow-up after initial OPN-therapy. Therefore, a regular long-term follow-up after acute OPN-therapy and even low-dose antibiotic long-term prophylaxis should be discussed in adults, as some authors recommend it for children with upper urinary tract dilatation because of UTI rates between 4.3 and 36% during a 1-year follow-up without prophylaxis [25]. Because patients with tumors are followed anyhow, this recommendation is especially true for patients after acute OPN-therapy due to urolithiasis, malformations of the urinary tract, or other causes.

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References

1 Robins SA, Fischmann J: Hydronephrosis: a radiologic classification based on anatomical variations. Radiology 1948;50:632–638.

2 Demertzis J, Menias CO: State of the art: imaging of renal infections. Emerg Radiol 2007; 14:13–22.

3 Tambo M, Okegawa T, Shishido T, Higashihara E, Nutahara K: Predictors of septic shock in obstructive acute pyelonephritis. World J Urol 2014;32:803–811.

4 Browne RFJ, Zwirewich C, Torreggiani WC: Imaging of urinary tract infection in the adult. Eur Radiol 2004;14:E168–E183.

5 Bruns T: Harnwegsinfektionen, ed 2. Bremen, Uni-Med, 2006.

6 Soulen MC, Fishman EK, Goldman SM, Gatewood B: Bacterial renal infection: role of CT. Radiology 1989;171:703–707.

7 Vahlensieck W: Pyelonephritis und Nierenabszess; in Schmelz HU, Sparwasser C, Weidner W (eds): Facharztwissen Urologie Differenzierte Diagnostik und Therapie, ed 3. Heidelberg, Springer, 2014, pp 13–36.

8 Seitz C, Fajkovic H: Epidemiological gender-specific aspects in urolithiasis. World J Urol 2013;31:1087–1092.

9 Vahlensieck EW, Bach D, Hesse A: Incidence, prevalence and mortalitiy of urolithiasis in the German Federal Republic. Urol Res 1982; 10:161–164.

10 Ifergan J, Pommier R, Brion MC, Glas L, Rocher L, Bellin MF: Imaging in upper urinary tract infections. Diagn Interv Imaging 2012; 93:509–519.

11 Ng CK, Yip SK, Sim LS, Tan BH, Wong MY, Tan BS, Htoo A: Outcome of percutaneous nephrostomy for the management of pyonephrosis. Asian J Surg 2002;25:215–219.

12 Bartsch GC, Kuefer R, Gschwend JE, de Petriconi R, Hautmann RE, Volkmer BG: Hydronephrosis as a prognostic marker in a bladder cancer in cystectomy-only series. Eur Urol 2007;51:690–697.

13 Christoph F, Weikert S, Müller M, Miller K, Schrader M: How septic is urosepsis? Clinical course of infected hydronephrosis and therapeutic strategies. World J Urol 2005;23;243–247.

14 da Costa JB, Cornu JN, Levgraverend D, Cordel H, Ridel C, Letendre J, Traxer O, Tligui M, Haab F: Pyonephrosis caused by Salmonella typhi: a case report. Urol Int 2014, [Epub ahead of print].

15 Zhang X, Niu S, Zhang L: Antimicrobial susceptibilities and clinical characterization of Pseudomonas aeruginosa isolates from urinary tract infections. Urol Int 2014;93;464–469.

16 van Nieuwkoop C, Hoppe BP, Bonten TN, van't Wout JW, Aarts NJ, Mertens BJ, Leyten EM, Koster T, Wattel-Louis GH, Delfos NM, Ablij HC, Elzevier HW, van Dissel JT: Predicting the need for radiologic imaging in adults with febrile urinary tract infection. Clin Infect Dis 2010;51:1266–1272.

17 Kawashima A, Sandler CM, Goldman SM: Imaging in acute renal infection. BJU Int 2000;86(suppl 1):70–79.

18 Heyns CF: Urinary tract infections in obstruction of the urinary tract; in Naber KG, Schaeffer AJ, Heyns C, Matsumoto T, Shoskes DA, Bjerklund Johansen TE (eds): Urogenital Infections. European Association of Urology, 2010, pp 452–480.

19 Lin WR, Chen M, Hsu JM, Wang CH: Emphysematous pyelonephritis: patient characteristics and management approach. Urol Int 2014;93:29–33.

20 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.

21 Ramsey S, Robertson A, Ablett MJ, Meddings RN, Hollins GW, Little B: Evidence-based drainage of infected hydronephrosis secondary to ureteric calculi. J Endourol 2010;24: 185–189.

22 Türk C, Knoll T, Petrik A, Sarica K, Skolarikos A, Straub M, Seitz C: Guidelines on Urolithiasis. European Association Urology, 2013.

23 Borofsky MS, Walter D, Shah O, Goldfarb DS, Mues AC, Makarov DV: Surgical decompression is associated with decreased mortality in patients with sepsis and ureteral calculi. J Urol 2013;189:946–951.

24 Li AC, Regalado SP: Emergent percutaneous nephrostomy for the diagnosis and management of pyonephrosis. Semin Intervent Radiol 2012;29:218–225.

25 Heyns CF: Urinary tract infection associated with conditions causing urinary tract obstruction and stasis, excluding urolithiasis and neuropathic bladder. World J Urol 2012; 30:77–83.