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SCRIPTA MANENT EDIZIONI

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SCRIPTA MANENT EDIZIONI

EDITORIALS

Dear Colleagues and UrOP Members,

Wishing You a happy, peaceful and prosperous 2010, I take this opportunity to greet all of You through the Publications of the "Italian Archive of Urology and Andrology" that, from this number, represents for the UrOP "the official journal" and also to track Association's statements of the past, present and future activities. In 2002 the founding Sicilian Members (Bartolotta, Tanasi, Leonardi, etc.) laid the foundations for a project that is being done in a unimaginable way then. We passed on the Italian Continent in 2005 with the expansion in the regions, as yet fundamental, Campania, Lazio, Puglia, Molise e Calabria. We opened our project to Toscana, Marche, Emilia-Romagna, Triveneto, Piemonte e Lombardia. We have great ambitions of development, for we are present in 108 out of 298 privately owned medical structures of Italian urology. For these reasons we must take actions at the colleagues who do not attend our Association activities as well as at those colleagues who still do not know us in order to let them register to our Society. It is certainly a hard-won conquest, but the incentive has to be the list of results so far obtained. Both in 2006 in Bologna – a surprise – but especially in Rimini in 2009 under the SIU (Italian Society of Urology) we have proven to be a cohesive group, solid, sure to represent the third force of Italian urology, after the University and the Hospital. We are among the founders and cornerstones of FISOPA (Italian Scientific Societies Federation of Accredited Private Hospitals) that links those who, like us, mostly by choice, are working in this area, where only about a third of medical professionals is in a dependent position. The Federation has a great prospects for the preservation of our professionalism and the equality between public and private career, nowadays still tied by obsolete rules of 1934 and essential for the more and more growing number of our young members. We have now settled on two annual single issue conferences (in spring and in autumn) and on the annual Congress. Our fith Congress, chaired by Domenico Tuzzolo, will be held in Formia on 6/7/8 May 2010 and is projected towards the Sixth Congress to be held in Iesolo with President Gaspare Fiaccavento. It will be the first over the Rubicone: alea iacta est! Not the least reason to be proud, thanks to stubbornness and ability of Carmelo Boccafoschi, we have our own official journal, with our Editorial Board, reviewed, to make heard our scientific voices, to publish our congressual documents, to give also voices to our young fellows who more and more follow us in our and their scientific activities and to promote their professional growth, entrusted to us. The Italian Urology has begun to recognize us, to identify and to request a comparison between the different realities that exist in the range of medical solutions, aimed at restoring the health of the Italians, whether compromised by injury and/or by diseases. Prospects for 2011 are even more exciting, but a little healthy Neapolitan superstition prevents me to anticipate them. Ad maiora!
With You and for You

Your President
Giuseppe Sepe

Dear Readers and UrOP Members,

As President of the UrOP (Urologi Ospedalità Privata) Scientific Committee, I am glad and honoured to announce that "Archivio Italiano di Urologia e Andrologia" became the official journal of our association. Personally, I find this agreement extremely important for the future of our association, because an official journal represents an incentive to improve the contents of our scientific production. In the editorial of this issue, our President described very well what UrOP is, so that there is no need to repeat it. I would just like to point out that "Archivio Italiano di Urologia e Andrologia" is written in English and revised by Medline, Index Medicus, EMBASE, Excepta Medica, Medbase and Current Opinion as well as recently by the data base SIIC, which is well-known in Latin America and which I believe to be a good viaticum for our "young" UrOP. A further reason for having chosen this journal as our official one is the fact that it is one of the most ancient Italian scientific journals, since 1924 interested in uro-andrological issues. Nevertheless, it has a modern layout and, as I said before, it is the only Italian journal indicated in the main medical data bases. UrOP will contribute by offering a high-level editorial board to select the papers that are going to be published. The fact of being connected to others scientific associations such as SIEUN (Società Italiana di Ecografia Urologica, Nefrologica ed Andrologica), AUL (Associazione Urologi Lombardi) and SIUrO (Società Italiana di Urologia Oncologica) allows the comparison with illustrious colleagues, not only urologists, but also with different specialisations, which represents an important factor of cultural growth for all of us. Remembering the birth of SIEUN and of SIUrO, I cannot hide a certain emotion due to the fact that I had been undeservedly asked by illustrious Masters of the Italian urology to be part of the Steering Committees since the beginning. For me this represented a great honour as well as an incentive for my scientific and cultural growth. In addition to the aforesaid, having a journal as an official organ will allow us to be closer to all the associates, because they will receive the journal for free and because the contents will include, in addition to the (free) publications, also some pages with information about the scientific-organisational and professional activities of our UrOP. Having said this, I would like to thank all the Members, the President, the past-President, the Steering Committee and the editorial staff for having given me the honour of being "Editor in Chief". I would also like to thank in advance the whole editorial board that, together with me, will have the honour and the burden of incentivise, revise and "criticise" the scientific production before this can be published. Nevertheless, we are facilitated in this task by having the opportunity to consult two illustrious Masters of the international urology such as Angelo Acconcia and Salvatore Rocca Rossetti, prestigious members of UrOP. I cannot conclude this editorial without a special thank to my friends Alberto Trinchieri and Massimo Maffezzini who, in a far-seeing way, believed in us and made many efforts in order to give UrOP an official organ through which we can carry on with our interests in the urological-andrological field. Besides, we can support with our experiences an already well-known and appreciated journal. I am looking forward to receiving many articles from you and once again I would like to point out my availability at the service of UrOP which represents in an unquestionable way a real and strong matter of fact in the Italian urology.

Carmelo Boccafoschi

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ORIGINAL PAPER

Histological evaluation of prostatic tissue following transurethral laser resection (TULaR) using the 980 nm diode laser.

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Summary

Objectives: In the present study, we performed for the first time an histological evaluation after 980 nm diode laser treatment of bladder outlet obstruction secondary to benign prostatic hypertrophy (BPH). The aim was to demonstrate the possibility of obtaining sufficient tissue for histological examination and the possibility of obtaining an histological diagnosis on the specimen obtained by laser resection.
Materials and methods: 86 patients with BPH were selected for laser surgery and 10 patients for transurethral prostate resection. The prostate tissue samples collected from laser surgery and transurethral resection of the prostate (TURP) were fixed in 10% formalin and serial sections with a slice thickness of 5-7 micron embedded in paraffin and stained with haematoxylin and eosin.
Results: Samples obtained using the 980 nm diode laser ranged in size from 4 mm to 30 mm and showed brownish, smooth margins. Lasered tissue showed a coagulation rim of 0.5 mm (range: 0.2-1 mm) and adjacent to the vaporized tissue, coagulated connective tissue and glandular epithelia were seen. Beyond this zone a complete detachment of glandular epithelia from the connective tissue was observed. Stromal oedema associated with ectasic vessels but without extravasation of red blood cells, haemosiderin deposition and haemorrhagic areas were also retrieved. All cases showed occlusion of small vessels beyond the zone of coagulated tissue. Unlike laser treatment, samples obtained from TURP showed extravasation of red blood cells, haemosiderin deposition and haemorrhagic areas.
Conclusions: The 980 nm diode laser provides high rates of tissue ablation, associated with excellent haemostasis. It has been shown that tissue samples can be obtained with this technique, which allow a histological diagnosis of BPH to be made. The current method involving the 980 nm diode laser induces a vaporesection of prostate tissue and the acronym of TULaR (transurethral laser resection) has therefore been created to describe this technique.

KEY WORDS: *Benign prostatic hyperplasia; Transurethral laser resection; 980 nm diode laser; Histology.*

Submitted 1 February 2010; Accepted 1 March 2010

INTRODUCTION

Benign prostatic hypertrophy (BPH) is a common condition among elderly men, with an estimated prevalence of up to 85% (1). For several decades transurethral resection of the prostate (TURP) has been the gold standard treatment for BPH (2), but recently new laser treatments for BPH have been developed. The advantages of laser surgery over TURP for treating low urinary tract symptoms (LUTS) secondary to BPH are the nearly bloodless field and the absence of fluid absorption during the procedure. While some lasers produce deep coagulation but no vaporization, others show excellent vaporization properties but almost no haemostasis (3, 4). A recently introduced diode laser operates in a contact pulsed mode at a wavelength of 980 nm and output power of up to 180 W. This wavelength offers the highest simultaneous absorption in water and haemoglobin, so that it is postulated to combine high tissue ablative properties with good haemostasis (5). One of the main criticisms of laser vaporization of prostate was the impossibility to obtain tissue for histological evaluation. It has been possible to retrieve tissue following treatment with the holmium laser, specifically through the holmium laser enucleation of the prostate (HoLEP) technique (6). In the present study, we performed for the first time a histological evaluation after 980 nm diode laser treatment of bladder outlet obstruction secondary to BPH. The aim was to demonstrate the possibility of obtaining sufficient tissue for histological examination and the possibility of obtaining a histological diagnosis on the specimen obtained by laser resection. Another objective was to evaluate the effects of the laser beam on prostate tissue. A comparison with the morphological changes induced in prostatic tissue by TURP is also reported.

Material and methods

From May 2007 to May 2009, 86 patients with LUTS associated with BPH were selected for laser surgery. Inclusion criteria were absence of response to medical treatment (α1-blocker/5α-reductase inhibitor therapy for > 1 year), maximum flow rate (Qmax) ≤ 15 ml/s, transvesically measured postvoid residual urine (PVR) volume > 100 ml and an International Prostate Symptom Score (IPSS) > 7. Patients were treated by a single surgeon using the 980 nm diode laser (Evolve^{TM}, Biolitec, Germany) supporting a side firing fibre with a 70° emitting beam as well as a conical one. The procedure was conducted under epidural anaesthesia. A laser power of 100 W in a pulsed mode (0.1 sec on; 0.01 sec pulse interval) was used in contact mode for vaporesection. Occasionally the procedure was finalized using a 70 W power in a continuous, non-contact mode to remove any residual tissue in order to achieve a regular and symmetric prostatic cavity. To obtain tissue for histological evaluation the side firing fibre was used with a lifting movement, first moving from the bladder neck to colliculus seminal creating a depth furrow, then rotating the fibre 90° and with the same movement of lifting in contact mode creating a progressive vaporization of the base of the prostate tissue. As with the TURP procedure, resected pieces of prostate tissue remained within the bladder until the end of the procedure when they were extracted. The conical fibre at a power of 80 W in pulsed mode was also used to resect tissue by moving from the bladder neck to the apex of prostate and then cutting the apex of pedicle tissue while proceeding in the opposite direction. Close attention was paid to maintaining normal ejaculation by preserving the bladder neck and ejaculatory triangle as previously reported (5). In addition, the muscle fibres at the bladder neck were also preserved. As a comparison, mono-polar TURP was conducted in 10 patients and samples were obtained during the procedure for histological examination. The prostate tissue samples collected from both procedures were fixed in 10% formalin and serial sections with a slice thickness of 5-7 micron were embedded in paraffin and stained with haematoxylin and eosin (H & E). The depths of coagulation zones were measured after H & E staining under the microscope with the use of a calibrated caliper.

Results

The mean (range) prostate size as estimated by transrectal ultrasound in the patients treated with the 980 nm diode laser was 71.2 (60-100) g. Based on prostate size and lasering time the mean (range) vaporization rate was determined as 1.08 (1-2) g/min. Blood loss during the procedure was minimal. The mean reduction of hematocrit was less than 0.5%.

Samples obtained using the 980 nm diode laser ranged in size from 4 mm to 30 mm and showed brownish, smooth margins (Figure 1). Histological examination of samples obtained from laser treatment and TURP showed the same morphological features of BPH without any sign of atypia. Lasered tissue showed a coag-

Figure 1.
Samples obtained by 980 nm diode laser resection.

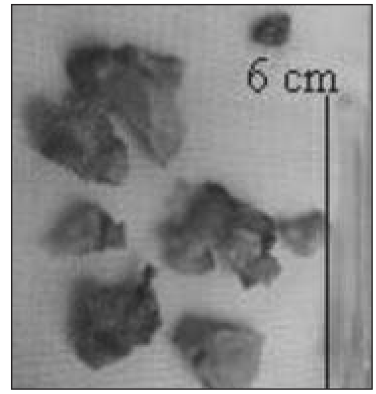


Figure 2.
The diode 980 nm laser at 100 W showed a coagulation rim of 0,5 mm (H & E; 100X).

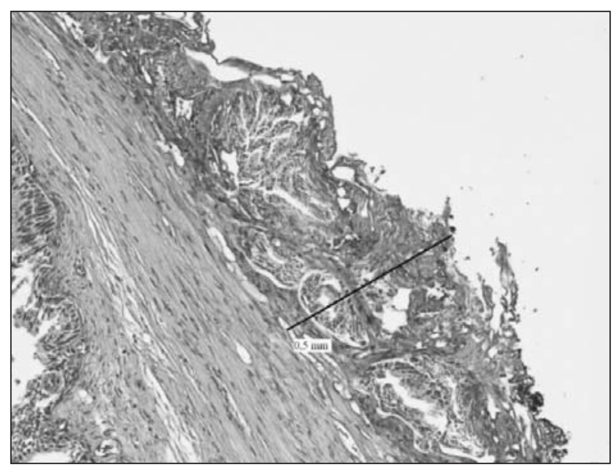


Figure 3.
Completely detachment of glandular epithelia from the connective tissue after treatment with the diode 980 nm laser at 100 W (H & E; 200X).

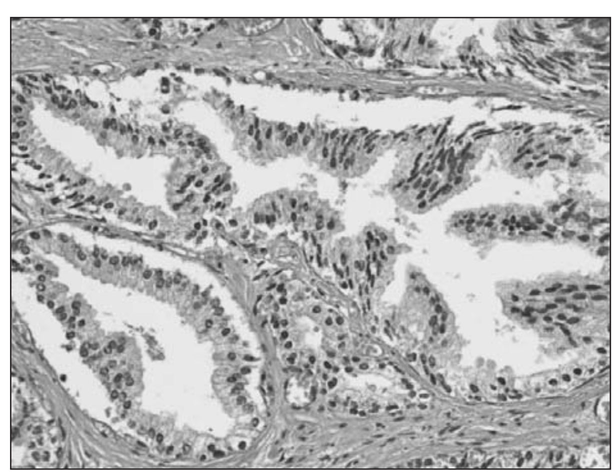


Figure 4.
Stromal oedema associated with ectasic vessels but without extravasation of red blood cells after treatment with the diode 980 nm laser at 100 W (H & E; 100X).

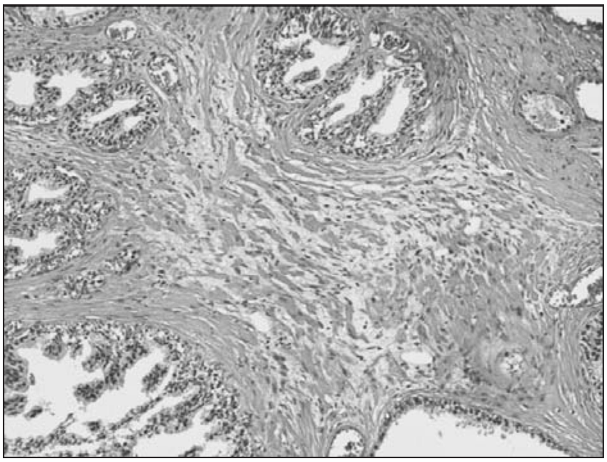


Figure 7.
Extravasation of red blood cells and hemorrhagic areas after transurethral resection of the prostate (TURP) (H & E; 100X).

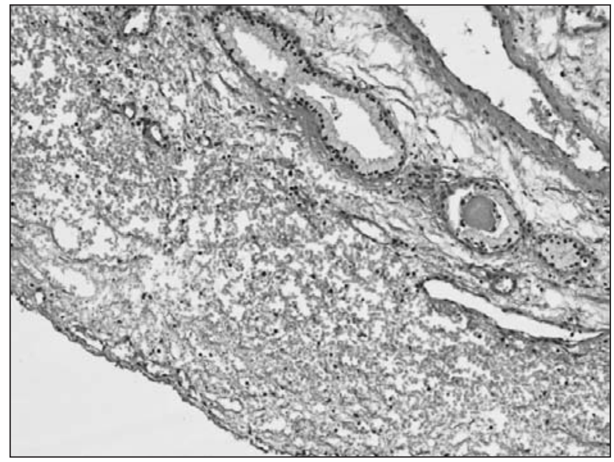


Figure 5.
Occlusion of small vessels after treatment with the diode 980 nm laser at 100 W (H & E; 400X).

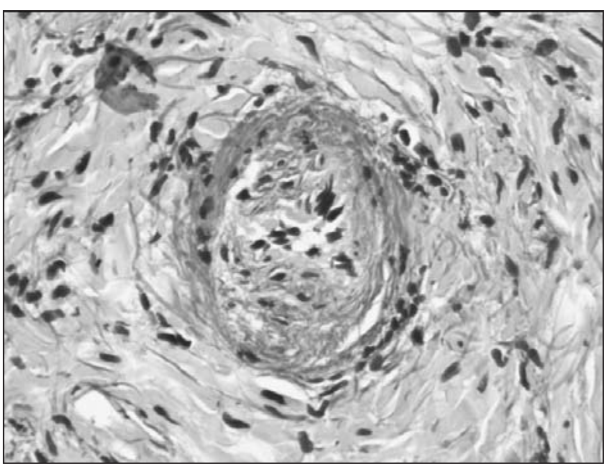
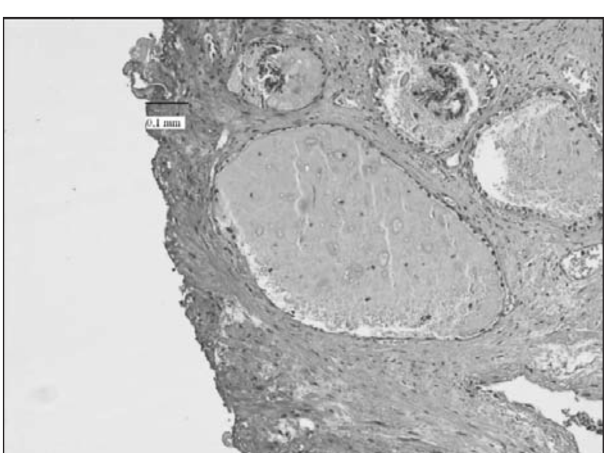


Figure 6.
Histological samples following transurethral resection of the prostate (TURP) showed a coagulation rim of 0.1 mm (H & E; 100X).



ulation rim of 0.5 mm (range: 0.2-1 mm) (Figure 2) and adjacent to the vaporized tissue, coagulated connective tissue and glandular epithelia were seen. Beyond this zone a complete detachment of glandular epithelia from the connective tissue was observed (Figure 3). Stromal oedema associated with ectasic vessels but without extravasation of red blood cells, haemosiderin deposition and haemorrhagic areas were also retrieved (Figure 4). All cases showed occlusion of small vessels beyond the zone of coagulated tissue (Figure 5).
Collections of lymphocytes, probably related to a previous chronic prostatitis, were an occasional finding. Samples obtained from TURP ranged in size from 5 mm to 20 mm and showed black, irregular margins. Histological evaluation showed a coagulation rim of 0.3 mm (range: 0.1-0.5 mm) (Figure 6). Next to the vaporized tissue, coagulated connective tissue and glandular epithelia were seen, but beyond this zone no detachment of glandular epithelia from the connective tissue was observed. Unlike laser treatment, samples obtained from TURP showed extravasation of red blood cells, haemosiderin deposition and haemorrhagic areas (Figure 7). No incidence of adenocarcinoma was noted in any of the prostate tissue samples.

Discussion

This study is the first report on the histological effects on prostate tissue following ablation with the 980 nm diode laser and the first time that such effects have been compared with the morphological changes caused by TURP. Data show that the coagulation depth with the 980 nm laser is consistently under 1 mm with 100 W pulsed power when used in contact mode, providing low thermal diffusion into the tissue. At the same time, the occlusion of small vessels justifies the haemostatic properties with minimal bleeding during the procedure. Histological evaluation showed two distinct zones within the ablated samples. The zone where the complete detachment of glandular epithelia from the connective

tissue was observed may result from lower thermal damage due to the wavelength used and to the technique itself. Unlike laser treatment, samples obtained from TURP did not show detachment of glandular epithelia from the connective tissue. This finding may be particularly relevant because the glandular epithelial detachment with minimal necrotic damage obtained with the laser treatment could lead to fibroblast activation and subsequent scarring in the prostate. This should facilitate a quickly recovery of the patient with few irritative symptoms after the treatment; however, further studies are needed in order to evaluate biopsy samples a few week after laser treatment to confirm our hypothesis.
An histological study of the changes induced during holmium laser resection of the prostate (HoLRP) revealed that changes that took place could be mistaken for malignant change. Thermal injury was more extensive than previously considered and artifacts observed under low power consisted of glandular distortion and contraction with crowding. Higher magnification revealed clumping of the chromatin of the nucleus, resulting in hyperchromasia and irregularity of the nucleus and loss of polarity (6). A later study has compared HoLRP and TURP and showed that HoLRP caused significant tissue vaporization and greater thermal damage than TURP (7). However, prostatic architecture was maintained in the majority of histological specimens. A comparative study looked at the histological effects on prostate tissue induced with HoLEP and TURP (8). Tissue samples that were removed during HoLEP revealed major histological alterations resulting from resection and coagulation on the external circumference of the enucleated tissue. Similar architectural and cytological artifacts were observed in HoLEP and TURP tissue specimens. These included distortion of the glandular structure with artifactual cellular detachment from the underlying basement membrane. The tissue obtained by TULaR can be used for histological diagnostic examination. Histological examination on the specimen obtained by laser resection is really important because it will confirm the BPH and exclude the presence of a malignant neoplasm not identified by previous biopsies usually performed before the laser treatment. In the comparative study on HoLEP and TURP, incidental carcinomas were identified in 7.5% of HoLEP samples and 10% of TURP specimens; high grade PIN was shown in 10% of samples in each treatment group (8). Although in the current study no cases of adenocarcinoma were reported, the sampling of tissue during TULaR leaves open the possibility of detecting malignant tissue.

Conclusions

The 980 nm diode laser provides high rates of tissue ablation, associated with excellent haemostasis. It has been shown that tissue samples can be obtained with this technique, which allow a histological diagnosis of BPH to be made. The current method involving the 980 nm diode laser induces a vaporesection of prostate tissue and the acronym of TULaR (transurethral laser resection) has therefore been created to describe this technique.

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ORIGINAL PAPER

PCA3: A new tool to diagnose prostate cancer (PCa) and a guidance in biopsy decisions. Preliminary report of the UrOP study.

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Summary

***Objectives:** PCA3 is a prostate specific non-coding mRNA that is significantly overexpressed in prostate cancer tissue. Urinary PCA3 levels have been associated with prostate cancer grade suggesting a significant role in the diagnosis of prostate cancer. We measured urinary PCA3 score in 925 subjects from several areas of Italy assessing in 114 the association of urinary PCA3 score with the results of prostate biopsy.*

***Material and Methods:** First-catch urine samples were collected after digital rectal examination (DRE). PCA3 and PSA mRNA levels were measured using Trascription-mediated PCR amplification. The PCA3 score was calculated as the ratio of PCA3 and PSA mRNA (PCA3 mRNA/PSA mRNA x 1000) and the cut off was set at 35.*

***Results:** A total of 925 PCA3 tests were performed from December 2008 to January 2010. The rate of informative PCA3 test was 99%, with 915 subjects showing a valid PCA3 score value: 443 patients (48.42%) presented a PCA3 score > = 35 (cut-off) whereas the remaining 472 patients (51.58%) presented a PCA3 score lower the cut-off limit (< 35). Of the 443 patients with PCA3 score > = 35, 105 (23.70%) underwent biopsy or rebiopsy. We found that 27 patients (25.71%) had no tumour at biopsy, 37 (35.24%) had HGPIN or ASAP and 41 (39.05%) had a cancer. Moreover, including the additonal 9 patients with PCA3 < 35, who underwent biopsy post PCA3 results, our data indicate that patients with negative biopsy (n = 31) show lower PCA3 score (mean = 54.9) compared with patients with positive biopsy (n = 45) (mean = 141.6) (p = 0.000183; two-tailed t-student test). The mean PCA3 score (79.6) for the patients diagnosed with HGPIN/ASAP at biopsy (n = 38) was intermediate between patients with negative and positive biopsy.*

***Conclusions:** Our results indicate that the PCA3 score is a valid tool for prostate cancer detection and its role in making better biopsy decisions. This marker consents to discriminate patients who have to undergo biopsy from patients who only need be actively surveilled: Quantitative PCA3 score is correlated with the probability of a positive result at biopsy.*

KEY WORDS: *Prostate Cancer Gene 3 (PCA3); Prostate Specific Antigen (PSA); prostate cancer (PCa), biopsy; Digital Rectal examination (DRE); Benign Prostatic Hyperplasia (BPH).*

Submitted 15 February 2010; Accepted 10 March 2010

INTRODUCTION

Prior to the 1990s, digital rectal examination (DRE) of prostate and measurements of serum prostatic acid phophatase (PAP) were utilised to screen patients at risk for prostate cancer (PCa). Subsequently, Prostate Specific Antigen (PSA) has been used worldwide for the early detection of prostate cancer (1). However, PSA-based screening has led to an increase in the diagnosis of low volume/low grade cancer that in some cases will not progress clinically during lifetime (2, 3).

Risk characterization based exclusively on serum total PSA (tPSA) values presents several inherent difficulties. PSA is apparently specific for prostate tissue but not for prostate cancer. Elevated values of serum tPSA are found in many benign conditions involving enlargement of the prostate (4-7), including BPH (4) and acute prostatitis (5) and PSA levels do not apparently correlate with disease aggressiveness. Therefore, there is a trend in clinical practice toward over-diagnosis and consequent over-treatment of prostate cancer patients (8). For this reason, there is a need for additional test to increase the probability of detecting PCa at biopsy and reduce the number of unnecessary biopsies. Recently, the urinary prostate cancer gene 3 (PCA3) assay has shown promising results for prostate cancer detection. This assay measures PCA3-messenger ribonucleic acid (mRNA) and prostate-specific antigen (PSA)-mRNA concentrations in post-digital rectal examination (post-DRE) urine (9). PCA3 also referred to as $PCA3^{DD3}$ or $DD3^{PCA3}$, was first described by *Bussemakers et al.* in 1999, is a noncoding, prostate specific mRNA that is highly over expressed in prostate cancer tissue compared with benign prostatic tissue and normal tissues (10). When analysed in parallel, several studies have demonstrated superior sensitivity and specificity of the PCA3 score over PSA level (11-12). These findings have suggested that PCA3 score could be used to improve the identification of men at risk of harbouring PCa and to reduce the number of unnecessary biopsies (13).

In this manuscript, we report the association of PCA3 score with the biopsy results (as gold standard) in a population of patients screened from December 2008 until January 2010 in a study of the Italian Urologist Association of Private Hospitals (UrOP).

Material and methods

Patients were men (925) subjected to PCA3 assay from December 2008 until January 2010 in Private Hospitals from different areas of Italy, mainly from: Casa di Cura Malzoni “Villa Platani”, Avellino, Italy; Casa di Cura Pio XI , Roma, Italy; Ospedale di Poggibonsi, Siena, Italy; Casa di cura S. Rita, Bari, Italy and Clinica Basile, Catania, Italy. Among them a total of 915 samples (99%) had concentrations of PCA3 and PSA mRNAs adequate to calculate the PCA3 score. The remaining 10 patients had previously been treated with radiotherapy. All men included in our study were studied for age, PSA level, DRE, prostate volume, history of previous biopsy and current prostatic therapy. DRE was classified as normal or suspicious. Prostate volume was calculated with TRUS using the prolate ellipse formula (0.523 x length x width x height) as described by Eskew. PSA levels were measured before DRE and TRUS.

First catch urine samples, were collected following DRE as described by Groskopf (9). The urine sample was processed and tested in the same laboratory using the same procedure to quantify PCA3- mRNA and PSA-mRNA concentrations using the Progensa PCA3 assay (Gen-probe Inc., San Diego, CA). Briefly, target mRNA was isolated from whole urine samples by capture onto magnetic microparticles coated with sequence-specific oligonucleotides. Captured mRNA was amplified by transcription-mediated amplification and detected with chemiluminescent DNA probes. PCA3 and PSA mRNA copy levels were calculated based on transcript calibrators. PSA mRNA levels were used to normalize PCA3 to the total amount of prostate RNA present in the sample and ensure that the RNA yield was sufficient for analysis. The PCA3 score was calculated using the formula, (PCA3 mRNA)/ (PSA mRNA) x1.000.

Biopsy specimens were evaluated by an experienced uropathologist at each site.

Results

Among the 915 subjects enrolled in this study, 749 (81.86%) had serum tPSA values higher than 4 ng/ml (range 4-102 ng/ml); 327 subjects (43.66%) had undergone a biopsy prior to PCA3 test. In particular, 266 out of 327 patients who have been subjected to biopsy (81.4%) presented no tumour, 51 (15.6%) were diagnosed with HGPIN/ASAP and 10 (3%) were diagnosed with prostate cancer.

The cut-off value for PCA3 test for this study was set according to the current literature (10) at 35 and patients were divided into PCA3 score positive (≥ 35) and negative (< 35). We found that 443/915 patients (48.4%) had a PCA3 score greater than or equal to the cut-off (PCA3-positive) and 472/915 (51.6%) were under the cut-off limit (PCA3-negative).

Of the 443 patients with PCA3 score ≥ 35, 105 (23.7%) had undergone biopsy or re-biopsy (Bx or ReBx): 27/105 (25.71%) presented no prostate lesion, 37/105 (35.24%) had HGPIN or ASAP and 41/105 (39.05%) had fully malignant cancer. In addition, 9 patients with PCA3 < 35 had undergone biopsies (for a total amount of 114 patients): 4 patients were negative (44.4%), 1 patient presented HGPIN/ASAP (11.2%) and 4 patients were positive for PCa (44.4%).

When matching the PCA3 score results with serum tPSA values we found that 82 patients were negative for both PCA3 score and serum tPSA, whereas 378 patients were negative for the PCA3 score and positive for serum tPSA, 60 were positive for the PCA3 score and negative for serum tPSA, 371 were positive for both markers and the remaining 24 had no previous tPSA value. We investigated the correlation between PCA3 score and the diagnosis of PCa in patients at biopsy. The characteristics of the patients who have undergone post-PCA3 biopsy are shown in Table 1. Patients’ mean age was 67 (median 68, range: 52-85); mean PSA serum level was 9 ng/ml (median 7 ng/ml; range: 0.67-66.5); DRE was suspicious in 27 patients (23.7%) and unsuspicious in 56 (49.1%). Prostate mean volume was 53.8 cm^3 (median 57 cm^3; range 21-108 cm^3); 39 patients (34.2%) had undergone a previous biopsy.

PSA mean levels, DRE and prostate mean volume were similar among the 3 groups (patients with negative biopsy, patients with HGPIN/ASAP biopsy and patients with positive biopsy).

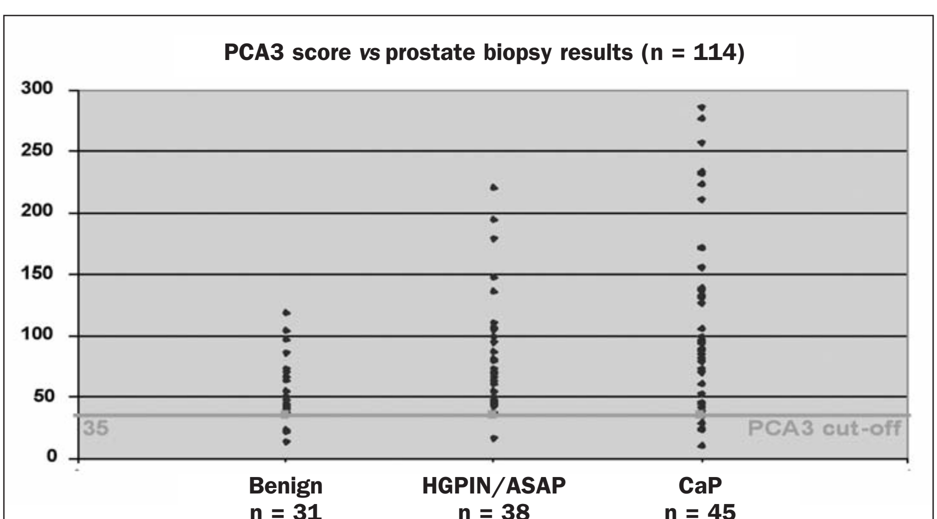
On the contrary, mean and median PCA3 scores were significantly higher in the group of patients with positive biopsy (n = 45) in comparison with the group with negative biopsy (n = 31) (141.6 and 97 *vs* 54.9 and 48, respectively) (p = 0.000183; two-tailed t-student test). It is of note that the mean and median PCA3 scores (79.6 and 66, respectively) for the patients diagnosed with HGPIN/ASAP at biopsy (n = 38) were intermediate

Table 1.
Characteristics of the population undergone BX or ReBX post PCA3 results.

	Men with neg biopsy n = 31		Men with HGPIN/ASAP biopsy n = 38		Men with pos biopsy n = 45		All evaluable men n = 114	
	Median number	mean ± SD (%) within the class	Median number	mean ± SD (%) within the class	Median number	mean ± SD (%) within the class	Median number	mean ± SD (%) within the class
Age (yr; n = 31; 38; 45; 114)	68	66.9 ± 6.5	66	66.4 ± 6.4	68	68.5 ± 7.1	68	67.4 ± 6.8
At least one previous negative biopsy (%)	12	(38.71%)	8	(21.05%)	11	(24.44%)	31	(27.19%)
PSA (ng/ml; n = 31; 36; 45; 112)	7	8 ± 6.4	7.23	8.8 ± 6.2	6.95	9.9 ± 10.4	7	9 ± 8.1
Men with serum PSA total								
< 4 ng/ml-n; (%)	6	(19.35%)	5	(13.16%)	5	(11.11%)	16	(14.04%)
4-10 ng/ml-n; (%)	18	(58.06%)	24	(63.16%)	28	(62.22%)	70	(61.4%)
> 10 ng/ml-n; (%)	7	(22.58%)	9	(23.68%)	12	(26.67%)	28	(24.56%)
Prostate volume (ml; n=7; 12; 8; 27)	58	60 ± 13.9	67	60.3 ± 29	40	40.6 ± 11	57	53.8 ± 23.1
Men with suspicious DRE (n; %)	8	(25.81%)	7	(18.42%)	12	(26.67%)	27	(23.68%)
PCA3 score	48	54.9 ± 26.2	66	79.6 ± 44.4	97	141.6 ± 120.1	70	97.4 ± 88.5

between the groups of patients with negative and positive biopsy.
Statistical analysis showed also that the difference in PCA3 score between negative and ASAP/PIN patients was significant (p = 0.00204; two-tailed t-student test) whereas the difference in PCA3 score between HGPIN/ASAP and positive patients was not significant.
The graph in Figure 1 summarizes the relationship between PCA3 score and prostate biopsy results.
All the patients who underwent post-PCA3 test biopsy (n = 114) were classified in 4 PCA3 score classes as follows: < 35 (n = 9), 35-49 (n = 26), 50-100 (n = 48), > 100 (n = 1). The results are shown in the Table 2. Only 9% of patients (4/45) with a positive biopsy were in the < 35 PCA3 score class, whereas 11.1% (5/45) of patients with a positive biopsy were in the PCA3 score 35-49 class, 35.5% (16/45) in the 50-100 PCA3 score class and 44.4% (20/45) in the > 100 PCA3 score class. These data demonstrate a direct correlation between the quantitative PCA3 score and the probability of a positive prostate biopsy. Interestingly, most patients (22/38, 57.9%) with diagnosis of HGPIN/ASAP at biopsy were concentrated in the 50-100 PCA3 score class.
In conclusion, our results indicate that higher PCA3 score may be predictive of a positive result in patients undergoing prostate biopsy.

Figure 1.
Prostate cancer gene (PCA3) score vs prostate biopsy results. PCA3 score Mean ± SD and median were: 54.9 ± 26.2 and 48 for men with negative biopsy, 79.6 ± 44.4 and 66 for men with HGPIN/ASAP biopsy, 141.6 ± 120.1 and 97 for men with PCa biopsy.



Discussion

In this study we determined the PCA3 score and the serum tPSA in a panel of 915 patients and in 114 of them we correlated them with the result of prostate biopsy. Our results indicated that the mean PCA3 score was significantly lower in patients with negative biopsy than in patients diagnosed with ASAP/PIN at biopsy or

Table 2.
Biopsies post PCA3 test vs. PCA3 score classes.

	PCA3 score classes				
	< 35	35-49	50-100	> 100	Total
PCa	4 (8.89)%	5 (11.11)%	16 (35.56)%	20 (44.44)%	45 (100)%
HGPIN/ASAP	1 (2.64)%	7 (18.42)%	22 (57.89)%	8 (21.05)%	38 (100)%
Neg	4 (12.90)%	14 (45.16)%	10 (32.26)%	3 (9.68)%	31 (100)%
Total	9 (7.89)%	26 (22.81)%	48 (42.11)%	31 (27.19)%	114 (100)%

Data are expressed as number of biopsies and percentage within the biopsies results

patients with positive biopsy. Previous studies have shown that PCA3 may have an important role in the identification of men at risk of developing prostate cancer. This conclusion is supported by previous work that has suggested the existence of a relation between tumour volume and PCA3 assay score (14) and that HGPIN is associated with an increased risk of PCa at repeat biopsy (15). Accordingly, in our study PCA3 score proved to be an effective marker since the probability of a positive repeat biopsy increases with rising PCA3 scores. Moreover, the finding that mean PCA3 score was higher in patients with HGPIN than in patients without HGPIN, suggest that the PCA3 score may also help in identifying men at risk of developing PCa.
As these results suggest, PCA3 score represents a powerful tool to measure individual risk to detect PCa and thus help select patients for prostatic evaluation. In fact it has been demonstrated that PCA3 score is superior to serum tPSA in predicting repeat prostate biopsy outcome and may be indicative of clinical stage of PCa (16). Further prospective studies should evaluate whether the PCA3 score may be used to monitor men with chronically elevated PSA levels at regular intervals for the development of clinically significant PCa.
In the present study the repeat biopsy was positive in 39.05% of men, a percentage that is similar to previously reported data (17).
In conclusion, this study confirms the role of PCA3 assay as a valid tool for prostate cancer detection and its role in making better biopsy decisions. This marker consents to discriminate patients who have to undergo biopsy from patients who only need be actively surveilled: quantitative PCA3 score correlated with the probability of a positive result at biopsy. The translation of PCA3 test into routinary clinical use will reduce unnecessary biopsy.

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ORIGINAL PAPER

Surgery for renal cell carcinoma in two European urologic clinics: To compare or compete?

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Summary

Objectives: To evaluate and compare the incidence, TNM staging and the current strategy for the surgical treatment of renal cell carcinoma (RCC) in two European urologic institutions, situated in Varna, Bulgaria and in Bari, Italy. Both clinics have sound experience of RCC surgery, and modern laparoscopic equipment. A retrospective chart review of all patients with RCC diagnosed and treated in the last year was conducted at the two sites.
Materials and methods: In total, 88 patients (66 males and 22 females, mean age 58 years, range 24-81 years) were enrolled in the study. Comparisons were made between some clinical and pathologic parameters with an established prognostic and therapeutic impact. The type of surgery performed at both sites was analyzed as well. All these comparative studies were performed in relation to the 2008 EAU guidelines on the current management of RCC. Commercially available statistical software was used for the purpose.
Results: The results showed no difference between the two sites regarding the RCC incidence and the patients' age and gender. Significant differences (p value < 0.0001) emerged in terms of: the median size of the tumors at surgery (8.5 cm in Varna, SD ± 4.04 vs. 4.4 cm in Bari, SD ± 2.02); T-stage of the tumor (Varna T1-33%, T2-30%, T3-22%, T4-15% vs. Bari T1-64%, T2-12%, T3-24%, T4-0%); N-positive disease (24% vs. 2%); distant metastases (20% vs. 2%) and presence of necrosis in the renal masses (37% vs. 19%). Thus, 85% of Varna patients underwent open radical nephrectomy, 11% nephron-sparing surgery and 4% explorative laparotomy, due to inoperability of the renal mass. Only 29% of Bari patients were treated by open radical nephrectomy, 12% underwent laparoscopic nephrectomy, 57% open partial nephrectomy and 2% laparoscopic partial tumor resection.
Conclusions: These numbers demonstrate more advantageous tumour features at the Italian clinic in terms of organ-sparing surgical options (open and laparoscopic), whereas in the Bulgarian clinic the tumour features pose certain limitations to the application of modern surgical techniques. This difference is due to early diagnosis of RCC in Italy, allowing treatment of smaller volume tumors.

KEY WORDS: *Renal cancer; Radical nephrectomy; Nephron-sparing surgery; TNM classification; Europe; mortality.*

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INTRODUCTION

Over 200,000 new cases of kidney cancer are diagnosed yearly worldwide and the disease accounts for approximately 100,000 deaths each year. The highest incidence is found in North America, Europe, and Australia (1).
Surgery of early detected renal cell carcinoma (RCC) can be curative, but 20-30% of patients present with metastases at the time of diagnosis. In addition, 20-40% of patients with primary localized disease develop metastases (2). The annual incidence of RCC is approximately 2% in Europe and this figure is continuing to rise. This can largely be attributed to a greater success in detecting small renal masses (< 4 cm), and has yielded a corresponding increase in the rate of surgical treatment of small tumors (3, 4).
In 1969, *Charles J. Robson et al.* published a paper describing what was later to be regarded as the gold standard for RCC radical surgery (5).

RCC prognosis is mostly predicted by pathoanatomical parameters. Primary tumor size is a key component of the TNM staging system and remains one of the most important prognostic factors for RCC. Numerous morphological as well as clinical criteria have been shown to impact the prognosis in patients with RCC: nuclear grade, histological subtype, sarcomatoid features, tumor necrosis, collecting system invasion, microvascular invasion, paraneoplastic syndromes, etc (6). On the basis of these and other parameters, various useful nomograms and scoring systems have been developed (7). In the future, molecular biomarkers may be more effective for predicting outcome than traditional parameters. The development of techniques detecting the expression of numerous other genes has led to the identification of a number of prognostic biomarkers which need further validation (6).

Materials and methods

This study reports a retrospective analysis of patients surgically treated for RCC over a period of one year. We compared a total number of 88 patients treated with radical nephrectomy or nephron-sparing surgery for a renal mass over the period Jan 2007 – Feb 2008 at two European urological clinics – the Urologic and Kidney Transplantation Unit at the University Hospital Polyclinic of Bari, Italy and the Division of Urology at the Third Surgical Clinic of University Hospital "St. Marina" Varna, Bulgaria. Clinical features of the Bulgarian patients were: total number 46, 11 females (23.9%), 35 males (76.1%), median age at surgery 57.39 (35-81, SD ± 9.337). The Italian patients treated over this period were: total number 42, 11 females (26.2%), 31 males (73.8%), median age 59.02 (24-80, SD ± 12.71). We analyzed and compared the size of the renal mass, the TNM stage, the histological type, the type of surgical procedure, the presence of necrosis, adrenal or venous involvement and some clinical features including major symptoms at the time of diagnosis. Statistical analysis to compare the differences between groups was performed using Student's T-test with SPSS® for Windows, v. 16.

Results

There was no significant difference in median age (57.39 years in Varna, SD ± 9.337 and 59.02 in Bari, SD ± 12.71) and gender (76.1% male - Varna, 73.8% - Bari) but the distribution according to TNM stage revealed significant differences in the two clinics, as shown on Figure 1. The number of patients who underwent renal surgery for RCC in stage T1 was double in Bari and no T4 tumors were resected during the study period. The number of patients with positive LN was ten-fold higher in Varna. As regards distant metastases at the time of surgery, a similar ratio was observed (Figure 1).

Figure 2 shows the distribution of clinical cases according to the size of the tumor. It is clear that the majority of renal masses operated in Bari measured 5cm or less, while those in Varna are grouped around the size of 9cm (median size in Varna 8.5 cm, SD ± 4.04 and in Bari - 4.41 cm, SD ± 2.02).

The difference in the surgical approach is a direct consequence of the pathoanatomical differences discussed above

Table 1.

Comparison of surgical approaches used in the two Europen clinics for patients with RCC.

Type of Surgery	Bari	Varna
Open Radical Nephrectomy	29%	85%
Open Partial Nephrectomy	57%	11%
Laparoscopic Nephrectomy	12%	0%
Laparosc. Partial Nephrectomy	2%	0%
Exploration	0%	4%

Figure 1.

Distribution of patients with RCC according to TNM staging system in the two European clinics.

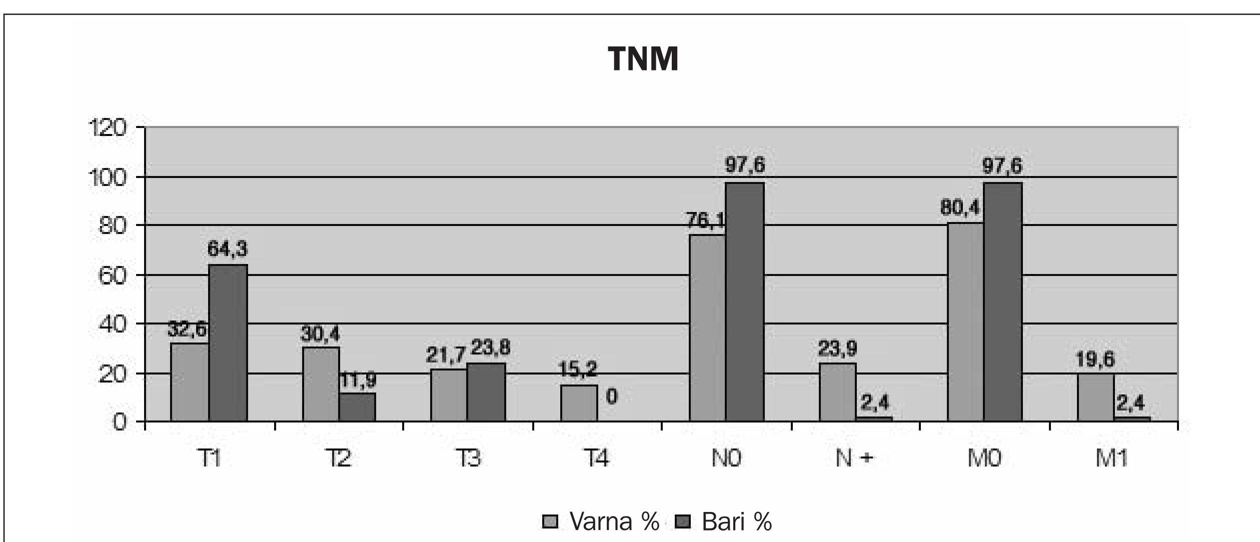
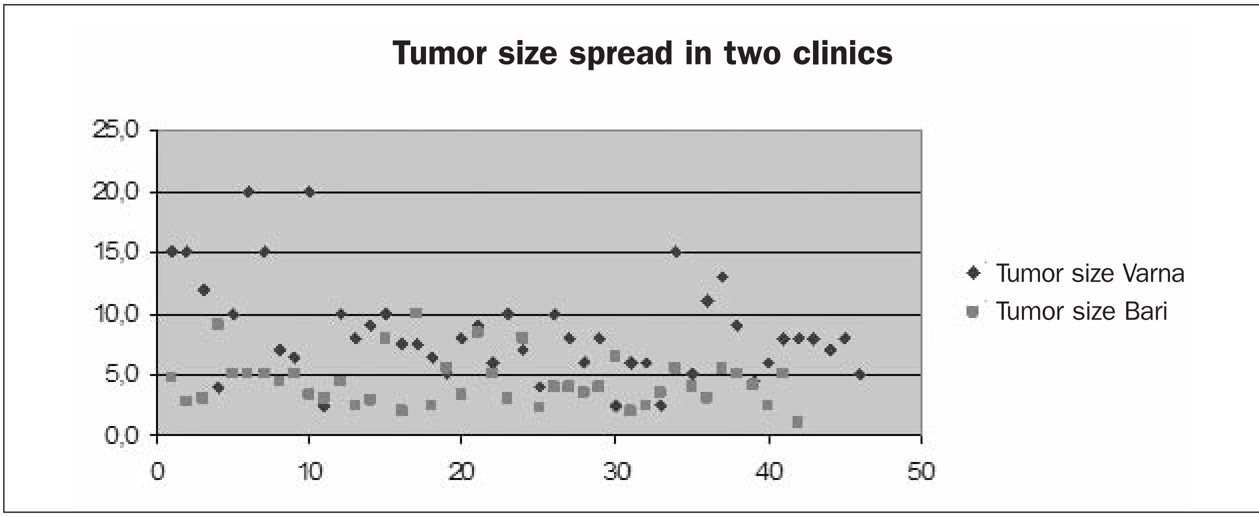


Figure 2.
Distribution of clinical cases according to the size of the tumor.



(Table 1). In Varna 84.8% of the patients underwent radical nephrectomy, 10.9% nephron-sparing surgery and 4.3% explorative laparotomy only due to unresectable renal masses. In Bari only 28.6% were treated by radical nephrectomy, 57.1% underwent partial nephrectomy, 11.9% laparoscopic nephrectomy, and 2.4% partial laparoscopic resection. This difference is significant and demonstrates the need for a better early diagnosis of renal masses in Varna. Modern surgical approaches yield a better outcome in terms of patient recovery after surgery, better prognosis and preserved renal function. The presence of unresectable renal masses observed only in the Varna clinic suggests poor screening measures in Bulgaria or late referral to a specialist in urology for various reasons.

The presence of necrosis in the renal mass on histological investigation is a prognostic marker included in few prognostic score systems. We also evaluated the presence of necrosis, and again the result did not favour the Bulgarian population. The number of histological specimens positive for necrosis in Varna was twice that in Bari -37% vs 19%.

Other markers of advanced disease such as involvement of the adrenal gland and a venous thrombus were found in a small number of cases, that do not allow any conclusions to be drawn, but the prevalence was again higher among patients in the Bulgarian site (adrenal involvement in 4 cases in Varna and 2 in Bari, while there were 2 cases of venous thrombosis in Varna but none in Bari).

We also analyzed the patients according to major symptoms: gross hematuria, pain and palpable mass at the time of diagnosis. The percentage of patients presenting with symptoms was 43.5% in Varna, the rest being incidental findings; 33.3% of the Italian patients were symptomatic at diagnosis.

Discussion

Kidney cancer incidence and mortality rates have increased during the last years in different countries. In the European Union as a whole, mortality from kidney cancer peaked in the early 1990s at 4.8 per 100000 men and 2.1 per 100000 women, then declined to 4.1 per 100000 men and 1.8 per 100000 women. This trend is the expression of a decreased kidney cancer mortality that has been observed since the early 1990s in many western and central European countries. In Italy the mortality rates from kidney cancer per 100000 men and women were reduced by -12.3% and -13.5%, respectively, in 1992-2002. We have no data about the mortality rates for Bulgaria in the period 1992-2002, but taking into account another country in the same geographic area, such as Hungary, this pattern of reduced mortality is confirmed (-4.4% and -2.6% per 100000 men and women, respectively) (8). These data are partly a reflection of the decline in smoking prevalence, and partly the consequence of the increased use of new imaging diagnostic procedures that has anticipated the date of diagnosis, thus increasing the incidence of early stage tumors. This early diagnosis, together with the introduction of new targeted therapies, has contributed to improve the overall survival rate of patients with kidney cancer in many European countries.

The treatment of renal cell cancer has rapidly evolved over the last decade, showing a trend towards the widespread use of minimally invasive treatment options formerly considered purely experimental, for localized RCC .

Over the past 15 years laparoscopic procedures in urology have become a widely used approach for many surgical indications. In many centers laparoscopy is now an integral part of daily practice (9). The well-known difficult learning curve for laparoscopic procedures has led to the development of alternatives that shorten the learning curve and improve surgical outcomes.

In kidney surgery the popularity of hand-assisted nephrectomy is a good example of a pragmatic approach to shortening the learning process (10-12).

The radical nephrectomy described by Robson in 1963 [5], is considered the standard of care in the management of renal tumors and still remains the gold standard for comparison with any new surgical technique Although this standard has been confirmed for decades, urologists now question whether it should still be considered the gold standard, given the continual advances in surgical techniques and our improved knowledge of prognostic factors. As a result, it is in any case no longer considered the gold standard for the management of small tumors, and options for surgical procedures now extend to open partial nephrectomy, laparoscopic nephrectomy, and even laparoscopic partial nephrectomy (13, 14). Laparoscopic partial nephrectomy requires advanced surgical experience but is gaining increasing acceptance in the urologic community (15).

Our comparative study shows that despite well-equipped facilities and experienced surgeons, the application of novel surgical techniques strongly depends on diagnostics and early detection of renal masses in the population. In terms of the treatment of small renal tumors, there is no significant difference between the two clinics except for a preference for retroperitoneal access in the Italian centre and transperitoneal access in Bulgaria. The main difference in the proportion of minimally invasive surgery is attributable to the greater number of early stage tumors diagnosed in Bari as compared to Varna and of course, to the laparoscopic approach in the Italian clinic which is completely lacking at the Bulgarian clinic. Laparoscopic treatment is already a standard of care according to the EAU guidelines but it is burdened by a considerable learning curve.

Pathoanatomical parameters of renal cell tumors define the type of surgery performed and for this reason the TNM staging system provides good prognostic information, but there has been much debate about its accuracy. Primary tumor size is a key component of the TNM staging system and remains one of the most important prognostic factors for RCC. The most recent revision (2002) of the TNM staging system established the subdivision of T1 into T1a and T1b, using a 4 cm threshold which introduces limits to surgical options (16, 17).

The mean size of the renal masses detected in Varna, and the significantly greater number of N+ and M+ patients at the time of treatment, offered no options for different types of surgery. The results of our analysis show that in terms of surgery the Bulgarian clinic has not only to gain an improved experience of laparoscopic techniques but above all of diagnostics and early detection of renal cell cancer. This could involve the institution of a thorough screening program for RCC, performing ultrasonography in the entire population at risk in the region.

The higher percentage of accidental identification of RCC in Bari shows better screening for the disease or simply more frequently performed ultrasonographic or CT scan examinations in this population. This could be the key point in the early detection of RCC and could easily be improved in Bulgaria.

The relatively high incidence of advanced disease and mRCC at the Varna urology clinic also raises the issue of nonsurgical treatment options. The systemic treatment of RCC has long been a significant problem for urologists and medical oncologists due to the lack of response to conventional therapeutic strategies and poor survival observed in the majority of patients. Current EAU guidelines approve therapy with tyrosine-kinase inhibitors in metastatic RCC, which is a routine practice in the Italian but not in the Bulgarian clinic. This emphasizes the need to study the genetics and molecular pathology of this disease in order to better predict the response to treatment and prognosis in individual patients. Further research into prognosis and therapy should be directed towards an optimal use of new molecules.

Conclusions

Surgery remains the standard of care for localized RCC and also offers the best chance of achieving a cure. The emphasis here is on 'localised', which is the key point, together with new emerging options for adjuvant therapy for RCC. Early detection is crucial for performing a partial nephrectomy – the EAU standard procedure for T1a disease. The role of multitargeted therapy in the management of localized RCC remains to be defined, and until evidence appears to the contrary, nephrectomy will continue to be recommended. This brief comparison between the clinics in Bari and Varna has revealed huge differences in the surgical approach, strongly dependent on early detection and general health care, which can make the difference between comparing and competing within the EAU guidelines. In order to achieve better results in surgery, thorough screening could benefit populations with access to good health facilities and with a high incidence of RCC, as in the Varna region.

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ORIGINAL PAPER

Incidental urinary tract pathologies in the one-stop prostate cancer clinic.

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Summary

Objective: *We determined the prevalence of incidental urinary tract pathologies in patients referred to the one-stop suspected prostate cancer clinic and assessed the evaluation and outcome of these pathologies.*
Methods: *One hundred and ninety patients were referred to the one-stop suspected prostate cancer clinic over a 6-month period. The records of patients with incidental urinary tract pathologies were retrospectively reviewed for demographic characteristics, mode of clinical presentation, further investigations performed, the final diagnosis and the treatment given.*
Results: *Incidental urinary tract pathologies were detected in 12 patients (6.3%). Clinically significant pathologies were found in 4.7% patients (n = 9). Significant incidental findings included bladder cancers (n = 8) and renal cell carcinoma (n = 1). All of these patients had additional diagnostic investigations, required in-patient surgical treatment and have remained disease free at follow up. Trans-rectal ultrasound guided prostate biopsies were only performed in three cases and a diagnosis of prostate cancer was only made in one patient.*
Conclusion: *Incidental urinary tract pathologies among patients referred to the one-stop suspected prostate cancer clinic are common. This reflects the need for further investigating patients with lower urinary tract symptoms whenever necessary so avoid missing significant pathologies.*

KEY WORDS: *Prostate cancer; PSA; Incidental pathologies; Clinics.*

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INTRODUCTION

With the introduction of new UK Department of Health targets for the detection and treatment of cancer (1), patients with suspected prostate cancer are referred to a one-stop clinic and seen by a Consultant within 2 weeks. During the first six months of the introduction of the one-stop suspected prostate cancer clinic at our institution, it was noticed that amongst those correctly referred, some patients had additional incidental urinary tract pathologies which were not evident at the time of referral. In the absence of a strong literature base for this finding, we determined the prevalence of incidental urinary tract pathologies in patients referred to our one-stop suspected prostate cancer clinic, and assessed the evaluation and outcome of these patients.

METHODS

All patients referred to our one-stop suspected prostate cancer clinic were thoroughly evaluated with full medical history and physical examination including a digital rectal examination. Referral criteria were strictly based on the North East London Cancer Network guidelines (4), modified from the National Institute of Clinical Excellence (NICE) urological cancer guidance in England (5). Transrectal ultrasound-guided prostate biopsies (TRUS-Bx) were performed, at the same visit, if appropriate. Subsequently, the records of patients who were found to have incidental urinary tract pathologies on subsequent investigations were reviewed retrospectively for demographic features, mode of clinical presentation, further investigations performed, final diagnosis and its clinical significance, as well as treatment given. Incidental urinary tract pathologies were defined as abnormalities of the kidneys, collecting system, ureters, bladder, urethra and external genitalia (penis and testes), that were not known at the time of referral to the one-stop clinic and were only discovered with further evaluation of those patients. Clinical significance was considered high when a diagnosis of cancer was made,

Table 1.
The clinical features, results of investigations and treatment of patients with incidental urinary tract pathologies.

Patient No.	Clinical features	Investigations	Diagnosis	Treatment	Clinical significance
1	Haematuria	Urine cytology: Atypical cells USS/IVU & CT: LEFT Renal cyst Flexi: Bladder tumour	TCC bladder	TURBT	High (TCC Bladder) Low (Renal cyst)
2	Haematuria	Flexi: Bladder tumour	TCC bladder	TURBT	High
3	Haematuria	Flexi: Bladder tumour	TCC bladder	TURBT	High
4	Haematuria	Flexi: Bladder tumour	Urachal cancer	Partial Cystectomy	High
5	Haematuria Foreskin lesion	Flexi: Bladder tumour Penile Biopsy	TCC bladder BXO	TURBT Circumcision	High (TCC Bladder) Low (BXO)
6	Haematuria	Flexi: Bladder tumour TRUS-Bx: High PSA	TCC bladder Prostate Cancer	TURBT Radical Prostatectomy	High High
7	LUTS	USS/IVU: Bladder mass Flexi: Bladder tumour	TCC bladder	TURBT	High
8	LUTS	USS/IVU: Bladder mass Flexi: Bladder tumour	TCC bladder	TURBT	High
9	LUTS	USS/IVU & CT: LEFT Renal cyst Testes USS: RIGHT epididymal cyst	Epididymal cyst	Excision of epidydimal cyst	Low Low
10	LUTS	USS/IVU: Vesical stone Flexi: Vesical stone		Cystolithalopaxy	Low
11	LUTS	Flexi: Urethral stricture	Urethral Stricture	Optical Urethrotomy	Low
12	Back pain	USS/IVU & CT: LEFT renal mass CXR: Pulmonary metastases	Metastatic Renal Cell Cancer	Radical Nephrectomy	High

LUTS = Lower urinary tract symptoms
USS = Ultrasound
IVU = Intravenous Urogram
Flexi = Flexible Cystoscopy
TURBT = Transurethral Resection of Bladder Tumour
TCC = Transitional Cell Cancer
BXO = Balanitis Xerotica Obliterans

and patients with low clinical significance had other (benign) urinary tract pathologies.

Results

A total of 190 patients were referred with a mean age of 71 years (range 36-96 years), during the first 6 months of the start of the one-stop urgent prostate cancer assessment clinic. Of these, 188 patients (99%) were referred with a raised PSA and 2 (1%) were suspected to have a malignant feeling prostate by the General Practitioner. Incidental urinary tract pathologies were detected in 12 patients (6.3%) with a mean age of 75 years (range 63-87 years). The clinical features, results of investigations and treatment of the 12 patients with incidental urinary tract pathologies are listed in Table 1. All of these patients had undergone further evaluation with midstream sample of urine (MSSU), urine cytology, urinary tract ultrasound, intravenous urogram, CT scan or flexible cystoscopy, as appropriate. Highly significant clinical pathologies were detected in 9 patients; whereas 5 patients had pathology of low clinical significance (2 patients had dual pathologies). The most common incidental finding was bladder cancer (n = 8). All patients in our cohort underwent successful treatment for these pathologies, with subsequent follow up revealing disease free progress in all cases. With regards to suspected prostate cancer, of these 12 patients, the presenting PSA ranged between 4.2 and 15.6 (median 8.05) and digital rectal examination was abnormal in only 2 cases. Of the 12 patients with incidental urinary tarct findings, TRUS-Bx was only performed in three (25%) and only one case of prostate cancer was diagnosed (PSA 5.7; Gleason 3+3 = 6). Out of the 9 patients who did not have biopsy, four patients had significant co-morbidity and lack of 10-year life expectancy, three had documented urinary tract infection and frank haematuria was present in the remaining two patients.

Discussion

This study investigated the prevalence of incidental urinary tract pathologies in a cohort of patients referred to the one-stop suspected prostate cancer clinic. Twelve cases (6.3%) were identified, which would have otherwise remained undetected. Of these, the vast majority had pathologies of high clinical significance.

Very few studies exist in which incidental pathologies have been investigated in patients with suspected prostate cancer. *Hori et al.*, investigated 458 patients who underwent TRUS-Bx for suspected prostate cancer. Performing cystoscopy at the same time, they found that 43 patients (2.4%) had concomitant bladder cancer. Moreover, other pathology was also detected in 7% of cases (6). In a different study by *Mor et al.*, 225 patients who had organ-confined prostate cancer, and were candidates for radical prostatectomy underwent pre-operative cystoscopy. In this study, only 1.3% of patients (n = 3) had significant lower urinary tract findings (bladder tumour, stone and diverticulum) which altered the management of these patients (7). Furthermore, *Okazaki et al.* (8), found the prevalence of bladder cancer in 498 patients referred for TRUS-BX, to be 2.4% (n = 12 patients). Interestingly, this figure was not significantly different between those with prostate cancer and those with no prostate cancer. In our study, 8 cases (4.2%) of bladder cancer (7 cases of transitional cell carcinoma TCC and 1 case of urachal cancer) were detected while other pathologies were found in 2.1% of cases. The outcome of the current report, and evidence from previous studies, suggests that incidental urinary tract findings are more common than previously anticipated.

One of the reasons for higher prevalence of bladder cancer in these cohorts may be attributed to diagnostic bias, as patients who present with one genitourinary malignancy are more likely to have further investigations that result in the detection of more incidental pathologies. Interestingly though, in our study only one of the patients was actually diagnosed with prostate cancer, and thus diagnostic bias was presumably small.

In the majority of patients with incidental urological pathologies, highly significant pathologies were detected, with seven cases of TCC bladder, one urachal cancer and one case of metastatic renal cell cancer. Importantly, in the current study, patients were only investigated if there was a clear cut indication to do so and indeed in the remaining 178 patients, only 25 (14%) had further investigations. These findings suggest that further investigations were of clinical importance and benefit to the patient. Clearly, performing further diagnostic investigations, unrelated to the original referral characteristic, as well as in-patient surgical treatment constitutes an extra financial burden as well as an unforeseen source of anxiety for the patients.

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PRESENTATION

The Clavien classification system to optimize the documentation of PCNL morbidity.

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Summary

High success rates exceeding 90% are reported with percutaneous nephrolithotomy (PNL) and modifications have further decreased the morbidity while maintaining efficacy. However, complications after or during PNL may occur with an overall complication rate of up to 83%. Although results from several large series on PNL from outstanding centers are reported in the literature, there is still no consensus on how to define complications and stratify them by severity. Hampering comparison of outcome data may generate difficulties in informing the patients about the severity of PNL complications.
We therefore may conclude that standardization of complications of a certain procedure is necessary to allow comparison of outcomes between different centers, within a center over time, or between different instruments used and/or operating techniques.
In 1992, Clavien et al proposed general principles to classify complications of surgery based on a therapy-oriented, 4-level severity grading, allowing identifying most complications and preventing down rating. The Clavien Classification system differentiates in five degrees of severity upon the intention to treat. Several Urological teams have studied the use of classifications systems to document and grade outcomes and morbidity of interventions in urology.
Also the modified Clavien system has been applied in urological surgery. Urologists have been using this classification to grade perioperative complications following laparoscopic radical prostatectomy, laparoscopic live donor nephrectomy, and retroperitoneoscopy. In the field of endourology, it has been recently applied to PCNL procedures as well, allowing comparison among different series between different hospitals and within the same center.
Other benefits that the standardization of the complications by using the Clavien System allows is to give better information to the patient and, assisting them on making the correct therapeutical choice. There may also be a benefit for the health insurance bodies to obtain adequate information of the procedure, and the results achieved by a team.
Besides all its benefits, the modified Clavien system was proposed as a grading system for perioperative complications in general surgery and there are some limitations in classifying PCNL complications. A graded classification scheme for reporting the complications of PCNL may be useful for monitoring and reporting outcomes. There are some limitations in classifying PCNL complications. Minor modifications, especially concerning auxiliary treatments, are needed. Further studies are awaited for the development of an accepted classification system applicable to all urologic procedures.

KEY WORDS: *Percutanous Nephrolithotomy; Complications; Classification.*

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A growing demand for health care, rising costs, constrained resources, and evidence of variations in clinical practice have triggered interest in measuring and improving the quality of health care delivery. For a valuable quality assessment, relevant data on outcome must be obtained in a standardized and reproducible manner to allow comparison among different centers, between different therapies and within a center over time. Objective and reliable outcome data are increasingly requested by patients and payers (government or private insurance) to assess quality and costs of health care. To standardize the complications of a certain procedure is

necessary to allow comparison of different centers, comparison within a center over time, between different instruments and/or operating techniques. Moreover, health policy makers point out that the availability of comparative data on individual hospital's and physician's performance represents a powerful market force, which may contribute to limit the costs of health care while improving quality.
Traditionally, surgical series upon different procedures had been compared in between them regarding operative time, surgical complications and recovery after procedures. The lack of standardization was one of the facts which make a comparison difficult. To improve this comparison and standardization the medical community has been seeking for classification systems too.
In 1992, *Clavien et al.* proposed general principles to classify complications of general surgery based on a therapy-oriented, 4-level severity grading (1). Although that classification was used by some others groups, and served as the basis to assess the outcome of living related liver transplantation in the United States, it was not widely used in the surgical literature because of its limitations.
In 2004 the same group proposed a modified classification (2), which allows identification of most complications and prevents down-rating of major negative outcomes. This new classification has been widely accepted and applied throughout different countries and surgical cultures. It differentiates in five degrees of severity upon the intention to treat, ranging from 0, which means "no complications", to 5, which means "death" (Table 1).
High success rates exceeding 90% are being reported with percutaneous nephrolithotomy (PCNL) and modifications have further decreased the morbidity while maintaining efficacy. However, complications after or during PCNL may occur with an overall complication rate of up to 83%, including urinary extravasation (7.2%), bleeding necessitating transfusion (11.2-17.5%), and postoperative fever (21-32.1%), whereas major complications, such as septicemia (0.3-4.7%) and colonic (0.2-0.8%) or pleural injury (0.0-3.1%) are rare (3). Co-morbidities such as renal insufficiency, diabetes, morbid obesity, or cardiopulmonary diseases increase the risk of complications. Although results from several large series on PCNL from outstanding centers are reported in the literature, there is still no consensus on how to define complications and stratify them by severity. Hampering comparison of outcome data generates difficulties in informing the patients about PCNL complications.
The modified Clavien system has been recently applied in urological surgery. Urologist have been using this classification to grade perioperative complications following laparoscopic radical prostatectomy, laparoscopic live donor nephrectomy, and retroperitoneoscopy (4, 5). The use of standardized classification systems, such as the Clavien System allows comparing results achieved with different techniques and within different centers. It also describes some other results besides the complications, such as the learning curve of a procedure.
In the field of endourology, it wasn't until 2008 when *Tefekli et al.* (6) reported on this system for percutaneous surgery for the first time. Their results showed that grade II complications were the most commonly observed ones after PNL. Bleeding necessitating blood transfusion was the most frequent individual complication, observed in 11% of cases. Complications stratified as grade 1 and 2 in that series, were considered as minor, while grade 3, 4, and 5 were considered major according to other classification systems. However, the modified Clavien system is more objective and reproducible, representing a compelling tool for quality assessment.
It was *de la Rosette et al.* (7) who were able to use it as a

Table 1.
Meaning of the different grades among the modified Clavien System and its example in PCNL surgery.

GRADE	Meaning	Complications in Urology (PCNL)
0	No complications	No complications
I	Deviation from normal postoperative course without the need for intervention	Fever, Transient elevation of serum creatinine
II	Minor complications requiring intervention	Blood transfusion, Urine leakage < 12 h, Infections requiring additional antibiotics (instead of prophylactics), Wound infection, Urinary tract infection, Pneumonia
IIIa	Complications requiring intervention without general anesthesia	Double-J stent placement for urine leakage > 24 h, Double-J stent placement for UPJ and pelvis injury, Urinoma, Pneumothorax, Retention and colic due to blood clots
IIIb	Complications requiring intervention with general anesthesia	Ureter-bladder stone, Calyx neck stricture, UPJ obstruction, AV fistula, Perirenal hematoma needing intervention, Perinephritic abscess, Perioperative bleeding requiring quitting the operation
IVa	Life threatening complications requiring IC management (single organ dysfunction)	Neighboring organ injury, Myocardial infarction, Nephrectomy, Lung failure
IVb	Life threatening complications requiring IC management (multiple organ dysfunction)	Urosepsis
V	Death	Death

Table 2.
Example of comparison performed using the modified Clavien System for the evaluation of PCNL complications.

	De la Rosette (7)		**Tefekli** (6)	
Clavien	**Number**	**%**	**Number**	**%**
0	131	53,7	562	69,3
1	63	25,8	33	4
2	41	16,8	132	16
3a	1	0,4	54	6,6
3b	1	0,4	1	1,4
4a	1	0,4	9	1,1
4b	0	0	3	0,3
5	0	0	1	0,1
Missing	6	2,5	0	0
TOTAL	244	100%	811	100%

comparative tool, evaluating their results to those achieved previously by Tefekli, as well as within their team. The application of the Clavien system also allows to objectively demonstrate some other improvements in the technique, as it is to show an improvement in the complication rate in the same center when a specific setting is employed (Table 2). They showed a higher complication rate than the group of Tefekli, but with a lower Clavien score. This might mean that a tertiary center focused on endourology may have a lower complication rate. Another application of the Clavien system used by this group was to demonstrate the improvement of the surgical technique within time, illustrating a negative correlation of the Clavien score over time.

The PCNL procedure has a steep learning curve leading to a higher complication rate in the beginning of the experience. To define the learning curve for PCNL there are some potential surrogate markers. Although the most relevant clinical end points for PCNL are the stone clearance and the complication rate, they may not be the best tools for assessing the learning curve in the PCNL procedure (8). The application of the Clavien System for this purpose is also important, because it may help to correctly establish the number of cases for the learning curve.

Another benefit, that such a standardization like this offers, is the ability to provide more details and precise information to the patient, which can be reflected on the informed consent given prior to surgery. It is also very important for the insurance companies, in order to include compensation for the possible complications and maybe reward those that perform better.

The broad implementation of this classification may facilitate the evaluation and comparison of surgical outcomes among different surgeons and centers.

Besides all its benefits, the modified Clavien classification system was proposed as a grading system for perioperative complications in general surgery and there are some limitations in classifying PCNL complications. A graded classification scheme for reporting the complications of PCNL may be useful for monitoring and reporting outcomes. However, minor modifications, especially concerning auxiliary treatments (re-PCNL, ESWL, Ureteroscopy) as they are part of the stone treatment, are needed. Further studies are awaited for the development of an accepted classification system applicable to all urologic procedures.

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Percutaneous nephrolithotomy: An extreme technical makeover for an old technique.

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Summary

Introduction: Percutaneous nephrolithotomy (PNL) remains the treatment of choice for several forms of stone disease including: large stones, many cystine and struvite calculi, lower pole calyceal calculi, stones associated with anomalous renal anatomy, and stones in morbidly obese patients. Recent advances in the PNL technique appear to improve post-operative outcomes and reduce patient morbidity.
Materials and Methods: A thorough review of the recent urologic literature was performed to identify these alterations in technique and whether or not these changes have improved stone-free outcomes and/or reduced patient morbidity.
Results: Published series from several different centers have recently demonstrated that supine PNL is safe with specific benefits for the patient and several technical advantages for the surgeon. A number of currently available intracorporeal lithotripsy devices, specifically combination pneumatic and ultrasonic lithotrites, have been show to offer improved stone fragmentation and more efficient fragment clearance. Tubeless, stentless PNL appears to offer reduced flank pain and no stent-related symptoms following stone removal.
Conclusions: Further advances in the PNL technique will not only increase stone-free outcomes and reduce post-operative complications, but also significantly reduce peri-operative patient morbidity. Further large scale clinical trails are necessary to better define the benefits of supine PNL, improved intracorporeal lithotripsy devices and tubeless percutaneous nephrolithotomy.

KEY WORDS: *Percutaneous nephrolithotomy.*

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INTRODUCTION

Although shock wave lithotripsy is now the most commonly used method to manage renal calculi, there are many indications where percutaneous stone removal is the preferred mode of treatment. Some of these indications include: large stone size, hard stone composition, aberrant renal anatomy, failure of other modalities, and body habitus. While percutaneous nephrolithotomy (PNL) has been practiced for almost 30 years, a number of recent advances have improved stone-free outcomes and reduced patient morbidity. The following manuscript addresses these recent improvements in PNL technique.

MATERIALS AND METHODS

There are three major areas where the percutaneous nephrolithotomy procedure has undergone recent changes in technique: patient positioning, intracorporeal lithotripsy and post-operative nephrostomy tube management. A thorough review of the recent urologic literature was performed to identify these alterations in technique and whether or not these changes have improved stone-free outcomes and/or reduced patient morbidity.

RESULTS

Patient Positioning

Traditionally, PNL has been performed in the prone position which provides posterior access to the collecting system that theoretically reduced the incidence of significant parenchymal bleeding, peritoneal perforation and/or visceral injuries. The prone position, however, is often associated with restriction of the patient's respiratory movement and therefore is not always feasible.

Morbid obesity, compromised cardiopulmonary status and stature deformity provide significant challenges to both the anesthesiologist and the surgeon.

Published series from different centers have recently demonstrated that supine PNL is safe with specific benefits for the patient and several technical advantages for the surgeon. Because the tract is horizontal or slightly inclined downwards the pressure of the collecting system is very low, which may facilitate the spontaneous evacuation of stone fragments. Some have suggested that this more dependent position of the calyx in relation to the renal pelvis minimizes the possibility of a stone fragment migrating into the ureter during calculus fragmentation. The supine position also allows greater versatility during stone management, since ureteroscopy can readily be performed if there is contralateral ureteral stone or simultaneous procedures for renal, ureteral, and bladder stones in the same single supine lithotomy position. A final advantage of the supine PNL position is that urologists are more comfortable adopting a sitting posture during stone management.

Limitations of supine PNL include a decreased filling of the collecting system resulting in more difficult nephroscopy that may be more difficult because the collecting system is constantly collapsed and thus the surgical field is relatively small for nephroscopic maneuvers. In addition, the upper-pole calyx calyceal puncture is quite challenging because as the upper pole is becomes more medial and posterior and concealed deeply in the rib cage, when the patient is positioned supine.

Suggested ways to surpass these limitations would be to tilt the table toward the contralateral side or performing a simultaneous ureteroscopy.

Intracorporeal lithotripsy

Effective and efficient intracorporeal lithotripsy is integral to the success of percutaneous nephrolithotomy. Previous studies have demonstrated the efficiency of ultrasonic lithotripters in stone removal and the effectiveness of stone fragmentation with pneumatic devices. New devices which incorporate the combination of both ultrasonic and pneumatic lithotripsy shown to greatly improve the performance of these lithotrites.

A "second-generation" of combination pneumatic and ultrasonic lithotrites have been recently introduced which demonstrate improved stone fragmentation and more rapid fragment clearance during bench-top studies. One such combination pneumatic and ultrasonic lithotrite utilizes an optimized ultrasonic transducer providing a more stable and linear output, with a reduction in associated heat generation. These changes result in an approximately 50% increase in probe amplitude to input power ratio. As a secondary effect, the reduction in heating is thought to contribute to increased device durability. This change in device design also allows for easier changing from combination device to the ultrasound only device.

Post-PNL nephrostomy tube management

Multiple authors have reported their experience with tubeless percutaneous nephrolithotomy demonstrating its safety and efficacy. Postoperatively, tubeless PNL patients have an indwelling ureteral stent placed, which is often associated with stent-related morbidity. Recently, the concept of the tubeless-"stentless" PNL, where an open-ended ureteral catheter is left for < 24 hours, has been introduced to further reduce PNL-related morbidity.

In our early experience with this technique, patients undergo standard PNL and are left with an open-ended ureteral catheter, which had been placed at the start of the case. This ureteral catheter is removed on post-operative day 1. No nephrostomy tube or ureteral stent is left following the PNL procedure.

To date, we have performed tubeless, stentless PNL in almost 50 patients. Mean age 49.3 yrs (range 22-81), and mean stone burden of 532 mm^2 (range 99-2037 mm^2). Three patients (8%) had horseshoe kidneys. The cohort's mean ASA and BMI were 2.5 and 30.7 (range 14.2-61.4) respectively. The mean change in hemoglobin was 1.95 g/dL (range 0.5-4.7). Three patients (8%) required a blood transfusion. Mean LOS was 1.9 days and 24 patients (68.6%) were managed as outpatients. Seven patients (20%) had 2 nephrostomy tracts. Seven patients (20%) had supracostal access tracts. All complications occurred in patients with 2 nephrostomy tracts – 1 pleural effusion, 1 pulmonary embolus, and 1 hemothorax/pneumothorax. The complication rate associated with multiple tracts was 20% versus 0% in single tract patients. No patients had significant voiding symptoms following their discharge.

Discussion

Percutaneous nephrolithotomy remains the most tried and true technique for minimally invasive stone removal. Currently, PNL is reserved for management of difficult to treat stones an /or complex patients. While there have been some advances in PNL technique, only recently have we seen dramatic changes in patient positioning, intracorporeal stone fragmentation and post-PNL nephrostomy tube management. These alterations not only offer improved patient outcomes, but potentially reduce peri-operative patient morbidity.

Supine PNL has received considerable interest over the past few years. A supine patient position appears to be less demanding and time consuming than the standard prone positioning during PNL. Supine PNL has additional advantages of allowing combined PNL/URS for complex stones and the dependent calyceal position may minimize fragment migration down ureter. Moreover supine PNL appears to have advantages in obese patients. Yet, the disadvantages associated with supine PNL are decreased filling of collecting system during nephroscopy and the upper pole calyx becomes more medial and posterior, making upper pole access difficult. It is apparent that large-scale, randomized, clinical trials will be necessary to determine the ultimate role of supine PNL.

The combination pneumatic and ultrasonic lithotripsy appears to offer safe, effective and efficient stone removal. The pneumatic device can rapidly fragment stones while the ultrasonic portion of the lithotrite provides rapid removal of the stone fragments. Clinically, it has been our practice to begin percutaneous stone fragmentation with the combination device. Once the stone is significantly fragmented, the inner pneumatic probe can be removed to increase suction and the ability to stay in contact with the stone. This technique may help maximize the additional efficacy of fragmentation while decreasing the stone displacement seen with the ultrasonic plus pneumatic lithotripsy combination.

Since tubeless PNL was originally introduced in 1997, there have been more than 40 studies reporting on the benefits of not leaving a nephrostomy after completion of percutaneous stone removal. Most studies suggest no significant increase in post-operative complications, even if tubeless PNL is performed in patients with a large stone burden, multiple nephrostomy tracts or supracostal tracts. Yet, while all these studies have reported decreased flank pain, most patients have experienced ureteral stent-related morbidity, as an internal ureteral stent is placed at the completion of a "standard" tubeless PNL.

Recent studies suggest that tubeless PNL patients can be managed with an external ureteral catheter alone, which is removed on the first post-operative day. We have performed this "stentless" variation of the tubeless PNL technique in over 50 patients, with no significant flank discomfort and no ureteral stent-related symptoms. Yet, it is still unclear as to the correct indications and contra-indications in performing the tubeless, stentless PNL. Additional prospective, randomized trials are necessary to better define the ideal candidate for the tubeless, stentless PNL procedure.

Conclusions

In this era where shock wave lithotripsy (SWL) is the treatment of choice for the great majority of renal calculi, approximately 15-25% of calculi will require alternate treatment strategies. The vast majority of the stones that will not be adequately treated with SWL may be effectively managed with a percutaneous approach. The factors that favor PNL as the most appropriate treatment modality include large stone size, position in a lower pole calyx, cystine or struvite composition, and the presence of a coexisting anatomic abnormality. Further advances in the PNL technique will not only increase stone-free outcomes and reduce post-operative complications, but also significantly reduce peri-operative patient morbidity. Further large scale clinical trails are necessary to better define the benefits of supine PNL, improved intracorporeal lithotripsy devices and tubeless percutaneous nephrolithotomy.

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PCNL in Italy.

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Summary

***Introduction:** The first italian meeting on percutaneous nephrolithotomy (PCNL) was held in Milan in 1984. Since then PCNL has been practised in many centres but its diffusion has not been fast.*
***Material and methods:** A Medline search using as keywords: PCNL, Percutaneous nephrolithotomy, Percutaneous surgery, was performed, time limits 1983 to 2008 to look for contribution of italian authors in indexed journals. The proceeding and abstract book of the SIU (Società Italiana di Urologia) from 1984 were consulted to ascertain the number of communications presented to the italian national congress. The number of PCNL performed and hospital stay in Italy are official data from the Ministero della Salute website www.ministerosalute.it.*
***Results and discussion:** The number of papers published by italian authors on indexed journals, although of good quality, has been poor in the past but is rising in recent years. Also from the proceedings of the italian urological association an increase in the interest for PCNL is testify by the growing number of communications presented to the national congress. Of the 2555 PCNL performed in 2005 in Italy, 2513 were inpatient procedures with a mean hospital stay of 8, 11 days. Even if the number of procedures/year is increasing still there is a wide difference among different italian regions and PCNL can be considered an underutilized procedure.*
***Conclusions:** It is mandatory to increase the number of educational courses on PCNL to increase the number of urologists performing this technique and in order to minimize hospital stay and to reduce the number of repeated extracorporeal lithotripsy for large burden stones and, most of all, the number of open procedures still performed.*

KEY WORDS: *Percutaneous nephrolithotomy.*

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INTRODUCTION

In 1984 was held in Milan the first international course on urological surgery and endoscopy.
PCNL at that time was an emerging and promising technique, the pioneering papers by Alken on the Journal of Urology, and by Wickham on the British Journal of Urology being published in 1981. A dedicated instrumentation was finally available in the next few years and here in Milan it was the first time italian urologists could debate and compare their initial and limited experiences on percutaneous nephrolitotomy (PCNL). Any speaker presented no more than ten cases in its personal series.
One year later in 1985 a round table was held during the congress of the Società Italiana di Urologia (SIU) on "Comparison of open surgery, percutaneous surgery and extracorporeal lithotripsy in the therapy of urinary stones" but we had to wait more than ten years to debate again on PCNL as just during the SIU congress of Turin in 1998 a second round table on "the treatment of reno-ureteral lithiasis" was organized.

MATERIAL AND METHODS

A medline search using as keywords: PCNL, Percutaneous Nephrolithotomy, Percutaneous surgery, was performed, time limits 1983 to 2008 to look for contribution of italian authors in indexed journals.
The proceeding and abstract book of the SIU from 1984 were consulted to ascertain the number of communications presented to the italian national congress. The number of PCNL performed and hospital stay in Italy are official data from the Ministero della Salute website www.ministerosalute.it.

RESULTS AND DISCUSSION

Even if PCNL is a topic undoubtfully attractive, turning over the pages of the abstract book of the SIU congresses, just one or two oral communication or poster on percutaneous surgery were presented each year from 1984 to 2000. May be extracorporeal lithotripsy was at the beginning of our experience considered too favourably

Table 1.
Number and hospital stay of PCNL performed in 2005 in Italy.

Selected procedure:
Percutaneous nephrostomy with fragmentation
National survey 2005

Hospital

Institution	Children (< 14 years)		Adults (15-64 years)		Elderly (> 65 years)		Total		
	Males	Females	Males	Females	Males	Females	Males	Females	
AO/Gd	1	4	765	592	238	186	1004	782	N° patients
	6.00	9.00	8.00	7.83	9.03	8.87	8.24	8.08	Mean hospital stay
Pol/Irccs/	2	0	156	128	45	38	203	166	N° patients
Class/Altri	9.50	0	8.75	9.15	9.72	9.53	8.98	9.24	Mean hospital stay
CC Accr	0	0	163	113	40	24	203	137	N° patients
	0	0	6.50	6.68	8.41	7.25	6.87	6.78	Mean hospital stay
CC N-Accr	0	0	9	3	4	2	13	5	N° patients
	0	0	5.00	6.34	8.00	4.50	5.93	5.60	Mean hospital stay

Day Hospital

Institution	Children (< 14 years)		Adults (15-64 years)		Elderly (> 65 years)		Total		
	Males	Females	Males	Females	Males	Females	Males	Females	
AO/Gd	0	0	4	4	9	2	13	6	N° patients
	0	0	3.25	1.75	2.23	2.00	2.54	1.84	Mean hospital stay
Pol/Irccs/	0	0	1	0	0	0	1	0	N° patients
Class/Altri	0	0	5.00	0	0	03	5.00	0	Mean hospital stay
CC Accr	0	0	1	0	0	0	1	0	N° patients
	0	0	1.00	0	0	0	1.00	0	Mean hospital stay

LLegend for Type of Institution

AO/GD: Aziende ospedaliere e Ospedali a gestione diretta.

POL/IRCCS/CLASS/ALTRI: Policlinici Universitari, Istituti di ricovero e cura a carattere scientifico, Ospedali classificati, Istituti sanitari privati qualificati presidio USL, Enti di ricerca.

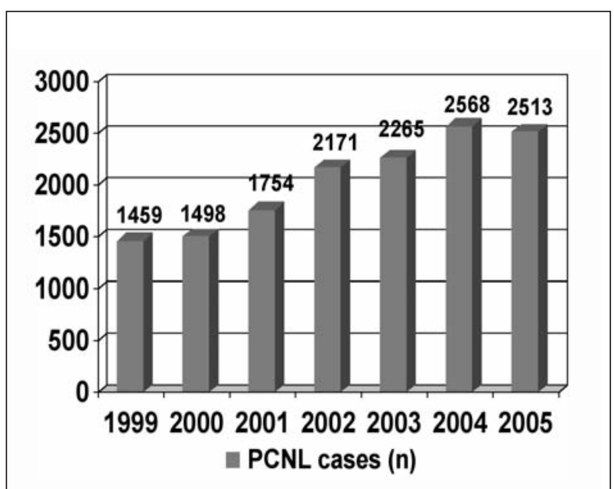
CC ACCR: Case di cura private accreditate.

CC N-ACCR: Case di cura private non accreditate.

and only in the last few years a rising interest in PCNL is demonstrated by the growing number of abstracts up to the fifteen published in 2008.

In the same way performing a medline search on PCNL related key words, a small number of papers by italian authors on indexed journal can be found. Nevertheless in the last decade many interesting articles have been published in impacted journals and I want to list some of them: *Montanari et al.*, Ultrasound-fluoroscopy guided access to the intrarenal excretory system. Ann Urol 1999; *Frattini et al.*, One shot: a novel method to dilate the nephrostomy access for percutaneous lithotripsy. J Endourol. 2001; *Francesca et al.*, Percutaneous nephrolithotomy of transplanted kidney. J Endourol 2002; Giusti et al, Miniperc? No, thank you! Eur Urol 2007; *De Sio et al.*, Modified Supine versus Prone Position in Percutaneous Nephrolithotomy for Renal Stones Treatable with a Single Percutaneous Access: A Prospective Randomized Trial. Eur Urol 2008; *Scoffone et al.*, Endoscopic Combined Intrarenal Surgery in Galdakao-Modified Supine Valdivia Position: A New Standard for

Figure 1.
Number of PCNL performed in Italy from 1999 to 2005.



Percutaneous Nephrolithotomy? Eur Urol. 2008. 24 years after our first meeting in Milan, PCNL is a standardized procedure widely performed in most of the referral urological italian centres. The current state of PCNL in Italy can be read on the official web pages of italian health care department Ministero della Salute (1). Unfortunately just data from 1999 to 2005 are available on line.
In 2005, 2555 PCNL procedures were performed, 2513 with a mean hospital stay of 8.11 days and 42 as day hospital (Table 1).
The most of the procedures, 1792, were done in Aziende Ospedaliere, the equivalent of a tertiary care hospital. The shorter hospital stay is registered in completely private hospitals, the longer in general hospital and teaching hospitals. Patients selection and economic issues can explain the shorter hospital stay in private clinics while the limited patients volume and surgeon experience the longer stay in general hospital.
Comparing data through the years (Figure 1), a progressive increase in the number of the procedures performed from 1999 to 2005 can be observed.
This should mean that the technique is appealing, is considered cost effective and that either more patients are referred to tertiary care centres, where the procedure is usually performed, or that more urologists have learned and are utilising this surgical technique.
If we can positively comment the increase in the number of the procedures performed we must remark that the hospital stay during the same years has not sufficiently decreased (Figure 2).
A mean of 8 days has to be considered too long for a minimally invasive technique. Maybe the slight increase observed in the last two years could be related to the larger number of urologists performing the procedure that have not still reached a sufficient expertise with PCNL and register a higher complication rate.
Analysing the data for each italian region (Table 2) a wide difference can be observed. In some of them no more than ten procedures/year are performed and while a comparison between 1999 and 2005 shows an increase in the number of procedures in most of the regions, in Trento province and in Basilicata the number is unfortunately reduced by almost 50%. And the lower the number of cases the longer is in general the hospital stay.
Finally comparing the data of treatment options for urolithiasis (Figure 3), there is a satisfactorily trend to an increase in the relative number of PCNL performed each year. 3% of the cases were percutanous surgery procedures in 1999 versus 5% of 2005. Still in 2005, 3% of the procedures were pyelolithotomies or nephropyelolithtomies. In United States already in 2000 open surgery represented no more than

Figure 2.
Hospital stay for PCNL procedures from 1999 to 2005.

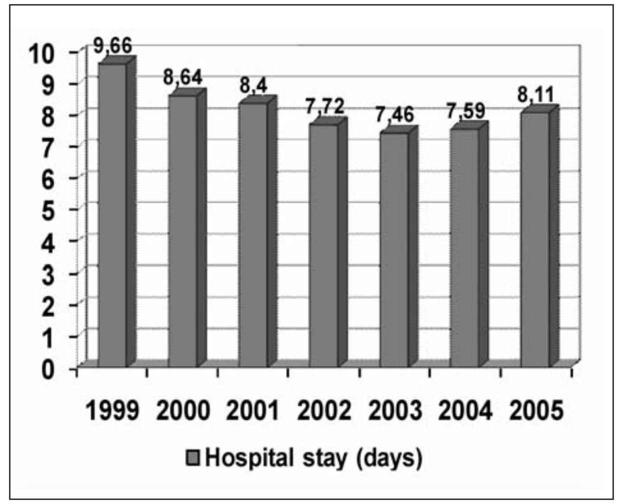
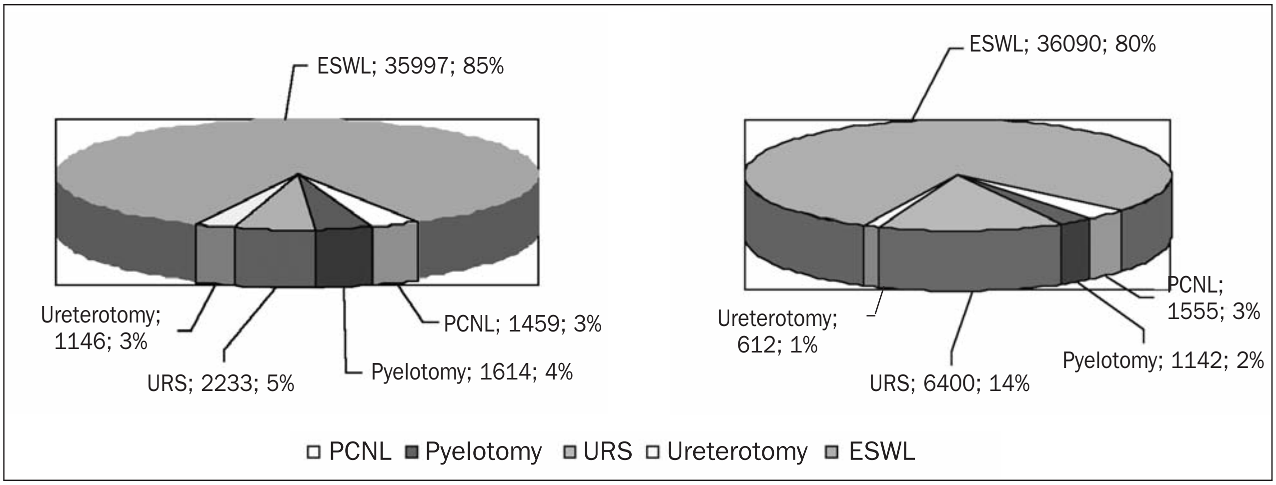


Table 2.
Comparison of the number of procedures and hospital stay between 1999 and 2005 in each italian region.

Selected procedure:
Percutaneous nephrostomy with fragmentation
Regional survey 2005

Region	N° patients	Mean Hospital Stay	N° patients	Mean Hospital Stay
Piemonte	42.0	9.41	104.0	7.75
Valle D'Aosta	3.0	15.00	6.0	10.00
Lombardia	231.0	10.20	427.0	8.05
P.A. Bolzano	6.0	22.50	19.0	8.69
P.A. Trento	26.0	17.81	14.0	9.36
Veneto	258.0	9.10	308.0	7.86
Friuli V.G.	45.0	9.09	68.0	8.43
Liguria	35.0	11.52	58.0	9.28
Emilia Romagna	163.0	8.15	285.0	7.11
Toscana	32.0	7.88	106.0	8.06
Umbria	4.0	9.75	5.0	12.20
Marche	36.0	5.92	82.0	8.35
Lazio	147.0	10.02	163.0	11.13
Abruzzo	46.0	8.24	81.0	7.62
Molise	2.0	15.00	26.0	13.12
Campania	134.0	11.36	264.0	7.15
Puglia	91.0	10.08	188.0	8.37
Basilicata	9.0	5.45	4.0	5.0
Calabria	36.0	8.56	29.0	10.76
Sicilia	95.0	8.32	197.0	7.47
Sardegna	18.0	12.95	79.0	7.42

Figure 3.
Comparison between 1999 (above) and 2005 (bottom) of the therapeutic procedures for urinary stones in Italy.



2% of the procedures for urinary stone treatment (including ureteral stones) while PCNL 5,5% and ESWL 70% (2).

Conclusion

Even if the number of PCNL performed in Italy has increased during the last years, still it is underutilized in our country. It is thus mandatory to increase the number of educational courses to teach this effective technique in order to minimize hospital stay and to reduce the number of repeated extracorporeal lithotripsy for large burden stones and, most of all, the number of open procedures still performed.

A wider diffusion of the technique could also contribute to promote italian urologists to publish their casuistry in impacted papers.

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PRESENTATION

The patient position for PNL: Does it matter?

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Summary

Currently, PNL is the treatment of choice for large and/or otherwise complex urolithiasis. PNL was initially performed with the patient in a supine-oblique position, but later on the prone position became the conventional one for habit and handiness. The prone position provides a larger area for percutaneous renal access, a wider space for instrument manipulation, and a claimed lower risk of splanchnic injury. Nonetheless, it implies important anaesthesiological risks, including circulatory, haemodynamic, and ventilatory difficulties; need of several nurses to be present for intraoperative changes of the decubitus in case of simultaneous retrograde instrumentation of the ureter, implying evident risks related to pressure points; an increased radiological hazard to the urologist's hands; patient discomfort. To overcome these drawbacks, various safe and effective changes in patient positioning for PNL have been proposed over the years, including the reverse lithotomy position, the prone split-leg position, the lateral decubitus, the supine position, and the Galdakao-modified supine Valdivia (GMSV) position. Among these, the GMSV position is safe and effective, and seems profitable and ergonomic. It allows optimal cardiopulmonary control during general anaesthesia; an easy puncture of the kidney; a reduced risk of colonic injury; simultaneous antero-retrograde approach to the renal cavities (PNL and retrograde ureteroscopy = ECIRS, Endoscopic Combined IntraRenal Surgery), with no need of intraoperative repositioning of the anaesthetized patient, less need for nurses in the operating room, less occupational risk due to shifting of heavy loads, less risk of pressure injuries related to inaccurate repositioning, and reduced duration of the procedure; facilitated spontaneous evacuation of stone fragments; a comfortable sitting position and a restrained X-ray exposure of the hands for the urologist. But, first of all, GMSV position fully supports a new comprehensive attitude of the urologist towards a variety of upper urinary tract pathologies, facing them with a rich armamentarium of rigid and flexible endoscopes and a versatile antero-retrograde approach. Prone position may still be useful in case of important vertebral malformations, specifically hindering the supine position, or for simultaneous bilateral PNL, without having to move the patient intraoperatively, so is still present in the complementary techniques of a skilled endourologist.

KEY WORDS: PNL; Ureteroscopy; Patient position.

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In 1941 *Rupel* and *Brown* performed the first percutaneous renal instrumentation, passing a cystoscope down an openly placed nephrostomy tract. In 1955 *Goodwin* and colleagues described the technique for percutaneous renal access; about twenty years later *Fernstroem* and *Johansson* developed the percutaneous nephrolithotomy (PNL) procedure for the treatment of large renal stones. Currently, PNL remains the treatment of choice for large and/or otherwise complex urolithiasis. It was initially performed with the patient in a supine-oblique position, but later on the prone position became the conventional one because of habit and handiness.

The prone position provides a larger area for percutaneous renal access, a wider space for instrument manipulation, and a claimed lower risk of splanchnic injury. Nevertheless, it implies:

a) important anaesthesiological risks – poorly perceived by urologists, but very familiar to anaesthesiologists, experiencing this position also for neurosurgery and orthopedic interventions –, including circulatory, haemodynamic, and ventilatory difficulties, particularly in obese patients and in case of long-lasting procedures;
b) need of several nurses to be present for intraoperative

changes of the decubitus in case of simultaneous retrograde instrumentation of the ureter, implying evident risks related to pressure points and possibly irreversible ocular, spinal or peripheral nerve injuries;

c) increased radiological hazard to the urologist's hands.

To overcome these drawbacks, various safe and effective changes in patient positioning for PNL have been proposed over the years, including the reverse lithotomy position, the prone split-leg position, the lateral decubitus, the supine position, and the Galdakao-modified supine Valdivia (GMSV) position (1).

Among these, the GMSV position, seems the most profitable and ergonomic one under many respects:

a) general anaesthesia is less hazardous, with optimal cardiopulmonary control;
b) in case of simple nephrostomy placement with local anaesthesia the patient is more comfortable;
c) it allows an easy puncture of a posterior calyx of the renal lower pole, which lies nearer to the skin, in spite its hypermotility if compared to the prone position;
d) the risk of colonic injury is less likely, as demonstrated in 1998 on the basis of CT studies (2), because in the supine position the colon floats away from the kidney;
e) there is no need of intraoperative repositioning of the anaesthetized patient, thus less need for nurses in the operating room, less risk due to shifting of heavy loads, less risk of pressure injuries related to inaccurate repositioning, reduced duration of the procedure (as recently demonstrated in a prospective randomized trial in 2008) (3);
f) it allows a simultaneous antero-retrograde approach to the renal cavities (PNL and retrograde ureteroscopy = ECIRS, Endoscopic Combined IntraRenal Surgery), a versatile approach for the treatment of large and/or complex urolithiasis (optimal endovision percutaneous renal puncture, preliminary evaluation of renal stones features, reduced need of multiple percutaneous accesses, immediate treatment of concomitant ureteral calculi or ureteropyelic junction stenoses; final visual control of the stone-free status);
g) the spontaneous evacuation of stone fragments is facilitated, because of the horizontal or slightly inclined downwards position of the percutaneous tract;
h) the urologist can work in a comfortable sitting position;
i) X-ray exposure of the surgeon's hands is restrained;
l) the learning curve of PNL in the GMSV position is very short, particularly for those who are familiar with prone PNL and are gifted with standard stereotactic abilities.

Therefore, we can conclude that the patient position matters a lot. In particular, the GMSV position is safe and effective in itself for anaesthesiological and management reasons. But above all the GMSV position supports a new comprehensive attitude of the urologist towards a variety of upper urinary tract pathologies, facing them with a rich armamentarium of rigid and flexible endoscopic instruments and a versatile antero-retrograde approach (4). Prone position may still be useful in case of important vertebral malformations, specifically hindering the supine position, or for simultaneous bilateral PNL, without having to move the patient intraoperatively, so is still present in the complementary techniques of a skilled endourologist (5).

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PRESENTATION

PCNL: Tips and tricks in targeting, puncture and dilation.

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Summary

Getting an effective and safe percutaneous access is the cornerstone in performing a successful and uneventful PCNL. The choice of the puncture site, according to our experience, is one of the most important factors that may influence the outcome of the procedure

Preoperative imaging has a preliminary role in choosing the kind of approach but the most important role has to be given to intraoperative retrograde pyelography following occlusion balloon catheter placing. Ultrasound-guided renal puncture as well may show adequate anatomic details of the collecting system if a retrograde dilation is performed

We routinary perform a single subcostal lower pole access. In our opinion, when the skin incision is located into the four-sided space between 12thrib, spine muscles, iliac crest and posterior axillary line, the risk of most non-haemorrhagic complications may be reduced. When the needle is proceeding towards its target, some radiological sign may confirm its correct insertion Dilation and operative sheath placing are the last steps of the percutaneous tract creation. Amongst the wide offer of dilating devices, our choice usually goes to the Amplatz fascial dilators associated to the "one-shot" technique and to the balloon hydraulic dilators.

KEY WORDS: *Percutaneous nephrolithotomy; Pyelography; Ultrasound; Dilation.*

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Getting an effective and safe percutaneous access is the cornerstone in performing a successful and uneventful PCNL. The choice of the puncture site, according to our experience, is one of the most important factors that may influence the outcome of the procedure and it deals with the risk of almost major complications: haemorrhagic and non-haemorrhagic ones.

When planning such a procedure, preoperative imaging has a preliminary role in choosing the kind of approach: intravenous urography may give in most cases sufficient details in the choice of the percutaneous path. But the most important role has to be given to intraoperative retrograde pyelography following occlusion balloon catheter placing: this allows to check the spatial configuration of the intrarenal collecting system with the patient lying in the working position and makes the choice of the right calyx easier.

The "dynamic pyelography" may show in real-time the subsequent opacification of the different calyces of the lower group, being the anterior one the first to be opacified when the patient is placed in the prone position. This helps in refining the target of the puncture, that is, in most cases, a posterior calyx. Ultrasound-guided renal puncture as well may show adequate anatomic details of the collecting system if a retrograde dilation is performed.

We routinary perform a single subcostal lower pole access. In our opinion, when the skin incision is located into the four-sided space between 12thrib, spine muscles, iliac crest and posterior axillary line, the risk of most non-haemorrhagic complications may be reduced. On the other hand, one of the critical point that may reduce the risks of haemorrhage is targeting the apex of the papilla.

When the needle is proceeding towards its target, some radiological sign may confirm its correct insertion. First, the pouring of contrast dye out of the calyx when it is compressed by the incoming tip of the needle. When the collecting system seems to be reached, a dripping of contrast dye, metilene blue or urine out of the needle may confirm its right positioning.

Actually, the absence of dripping may appear even when

a correct puncture has been performed, especially when the tip of the needle lies against the wall of the infundibulum. In these cases, a gentle suction attempt may be performed, rather than the injection of contrast dye, that may cause extravasation compromising the clearness of radiologic field. Moreover, in order to check the site of the needle tip, a J-tip floppy guidewire may be inserted through the needle looking if it rolls-up inside the collecting system.
If not suitable, and if high-burden stone is not present, a flexible retrograde renoscopy may be performed. As the tip of the scope faces the targeted calyx, the puncture would be addressed towards it under fluoroscopic guidance.

It's very important to remember that the feasibility of all these steps may be affected by several variables being fundamentally: the thickness of renal parenchyma, the volume of calyceal cavity and the stone burden.

Dilation and operative sheath placing are the last steps of the percutaneous tract creation. Amongst the wide offer of dilating devices, our choice usually goes to the Amplatz fascial dilators associated to the "one-shot" technique and to the balloon hydraulic dilators.

The hyper-mobility of the kidney is a critical aspect making dilation become hazardous. If the tip of fascial dilator pushes the kidney away when trying to perforate its capsule, severe vascular complications may occur. The following technical trick may be employed in most cases: making a guidewire proceed down to the ureter, then outside the urethra, if its two ends are secured the kidney will gain more stability during the dilating procedure. If this would not be safe or effective, depending on the over mentioned factors, balloon dilation must be considered.

Hydraulic systems may offer a more gradual, less traumatic, then safer dilation: before proceeding, the correct distance form the skin to the apex of the papilla must be carefully measured out on the basis of the puncture needle body and the reported on the balloon. This precaution should avoid the risks of extending dilation on the infundibulum of the calyx, with consequent injuries to the excretory system.

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Tubeless percutaneous nephrolithotomy: Our experience.

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Summary

***Purpose:** To evaluate safety and outcomes of tubeless PCNL in comparison with standard PCNL.*
***Materials and Methods:** Since June 2002 we have performed 99 tubeless PCNL. Tubeless technique involves antegrade placement of a 6Fr double-J stent without nephrostomy tube at the end of the procedure. This series has been compared with a total of 110 patients in which revision of operative reports ruled out the presence of intraoperative conditions necessary to candidate a patient to tubeless procedure but standard PCNL was performed because prior to its introduction or because of surgeon's attitude afterward.*
Mean stone burden was 5.4 for standard group and 4.9 cm^2 for tubeless group respectively. Mean BMI was 24.1 in the first group and 23.6 in the second one.
In this retrospective study, complications rate, postoperative pain, length of hospitalization and convalescence were evaluated by chart review.
***Results:** Hematocrit drop did not differ significantly between tubeless PCNL and standard PCNL (5.5% vs 5.90%). Conversely, there was statistically significant difference between tubeless and standard PCNL in terms of the amount of analgesics (49.5 vs. 84.2 mg), immediate postoperative patients' discomfort, hospitalization (2.2 vs 5.3 days) and time to resume normal activities (11.0 vs 16.5 days).*
***Conclusions:** In our series, tubeless approach did not determine increase in complication rate. Conversely, tubeless PCNL reduced analgesics' requirement, patients' discomfort, hospitalization and time to recovery. As such, at our Institution, tubeless PCNL has become routine procedure that actually is feasible in almost 2/3 of renal calculi suitable for percutaneous treatment.*

KEY WORDS: *Urolithiasis; Percutaneous nephrolithotomy; tubeless approach.*

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INTRODUCTION

In an effort to reduce hospital stay and patient discomfort related to PCNL, while maintaining the same positive outcomes, the need for the nephrostomy tube after completion of the procedure recently has come into question. Some recent reports (1-4) have challenged this cornerstone of the PCNL technique, demonstrating that in selected cases performing tubeless renal surgery (only antegrade placement of a double-J stent without an external drainage tube) is not as hazardous as thought during the pioneering era of endourology. Herein, we present our experience with tubeless PCNL.

MATERIALS AND METHODS

Since June 2002, we have performed 99 tubeless PCNLs for renal calculi. This series has been compared with a total of 110 patients in which revision of operative reports since opening of our "stone center" back in 1997 ruled out the presence of intraoperative conditions necessary to candidate a patient to tubeless procedure but standard PCNL (only 20Fr nephrostomy) was performed because prior to tubeless technique introduction back in June 2002 or because of surgeon's attitude after that date. Patients' demographics, stones' and procedures' characteristics are reported in Table 1 and 2.
Postoperative pain was assessed using a validated pain questionnaire including a visual analogue scale (VAS) and a verbal rating scale (VRS).

Tubeless surgical technique

After percutaneous access is obtained with the patient in

Table 1.
Demographics.

	Standard PCNL	Tubeless PCNL
Number of patients	110	99
Male/female	70/40	61/38
Mean age (years)	48.3 (29-70)	51.5 (23-77)
BMI	24.1	23.6
Right/left	60/50	56/43 (+ 1 simultaneous bilateral)
Solitary functioning kidney (%)	7 (6.3%)	1 (1.01%)

Table 2.
Stones' and procedures' characteristics.

	Standard PCNL (110 cases)	Tubeless PCNL (99 cases)
Stone burden (cm^2)	5.4± (2.2-27.2) cm^2	4.9 (2.1-12.0) cm^2
Number of stones (%)		
- Single	34 (30.9%)	42 (38.2%)
- Multiple	34 (30.9%)	33 (33.3%)
- Staghorn	38 (38.3%)	28 (28.4%)
Radiopacity of stones (%)		
- opaque	101 (91.8%)	9 (8.2%)
- lucent	92 (92.9%)	7 (7.1%)
Location of access site		
- infracostal	99	97
- supracostal	11	2

supine position, the tract is dilated up to 30Fr by means of a dilating balloon to place a 30Fr Amplatz working sheath. After the completion of the PCNL, a tubeless procedure is chosen if no major bleeding and/or perforations of the collecting system occurred and complete stone clearance is confirmed by intraoperative flexible nephroscopy and fluoroscopy. A 6Fr double-J stent is placed antegrade over the safety guidewire. The working sheath is then removed with the safety guidewire still in place checking accurately transparenchymal tract with rigid nephroscope in order to exclude major bleeding. The patient is carefully observed for 2 min and then the guidewire is removed and the nephrostomy wound is closed. An indweeling 18Fr Foley catheter is left in place overnight. Stent is then removed after about 1 week by means of ambulatory flexible cystoscopy.

Results

Operative and postoperative data are summarized in Table 3.

Discussion

Since its introduction two decades ago, PCNL has become the gold standard of care for large renal calculi.

In 1997 *Bellman et al.* (1) reported the first series of 50 tubeless PCNLs with results superior to standard PCNL in terms of reduced hospital stay, analgesic administration, and time to resume normal activities, with comparable complication rates between the groups. Subsequent series provided similar results, demonstrating that the placement of an external tube was more due to habit than to clinical necessity (2-4). Our series strongly corroborates these later findings. In particular, the lack of tamponade due to presence of the nephrostomy did not cause significant decrease of the in haematocrit value in the tubeless PCNL group compared to the standard group. As such, it is questionable whether the routine use of biological sealant in tubeless procedures to prevent bleeding.

Another major concern about not placing a nephrostomy is whether proper urinary drainage is guaranteed with a solely internal double-J stent and indweeling 18Fr Foley catheter overnight. In our experience we did not experi-

Table 3.
Overall results and statistical evaluation (statistically significant).*

	OR time (min)	ΔHt (%)	Transfused patients	Analgesics (mg)	Hospital Stay (days)	Time to normal activities (days)	VAS Score Day 1 postop	VRS Score Day 1 postop
Standard PCNL (110)	112.3	5.9%	6/110 (5.45%)	84.2	5.3	16.5	6.1	3.1
Tubeless PCNL (99)	98.1	5.5%	2/99 (2.02%)	49.5	2.2	11.0	3.5	1.9
Statistical evaluation		*p = 0.230*		*p = 0.003**	*p < 0.001**	*p < 0.001 **	*p < 0.001 **	*p < 0.001**

Table 4.
Tubeless PCNL rate throughout years.

	Tubeless/standard PCNL (rate)
2002	4/20 (20%)
2003	12/48 (25%)
2004	17/51 (33,3%)
2005	20/40 (50%)
2006	28/43 (65,1%)
2007	18/27 (66,6%)

enced urinomas. Instead, the potential hazard of placing only an internal double-J stent has become the key point to avoid prolonged urinary leakage through percutaneous tract and consequently to allow for reduction in hospitalization.
Our series indicated that tubeless PCNL results were superior in terms of less patient discomfort and reduced hospital stay. Patients who underwent tubeless PCNL required significantly less analgesics than the standard PCNL group, and the tubeless group had lower VAS and VRS pain scores on the first postoperative day as well. This finding suggests that the discomfort is mainly related to the presence of the tube itself, rather than to its bore (5, 16-18).
Based on these encouraging results, our confidence in tubeless technique increased with time and similarly raised the percentage of PCNL carried out in tubeless fashion (Table 4). As such, tubeless PCNL has become a routine procedure at our institution and actually is feasible in nearly two-thirds of patients with renal calculi suitable for percutaneous treatment.

Conclusion

In this series, omitting placement of nephrostomy in rigorously selected patients did not result in serious intraoperative complications. In addition, the tubeless approach offered significant advantages in terms of reduced amount of analgesics, less discomfort, and shorter hospital stay and time to return to normal activities.

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PRESENTATION

High burden and complex renal calculi: Aggressive percutaneous nephrolithotomy *versus* multi-modal approaches.

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Summary

***Introduction:** Percutaneous nephrolithotomy (PNL) remains the treatment of choice for managing patients with large or complex renal calculi, especially staghorn stones composed of struvite. Recent advances in the PNL technique appear to improve post-operative outcomes and reduce patient morbidity.*

***Materials and methods:** A thorough review of the recent urologic literature was performed to identify results and benefits of percutaneous nephrolithotomy versus either combination PNL and shock wave lithotripsy or SWL alone. A brief description of these three modalities is presented.*

***Results:** Published series from several different centers, as well as the 2004 report from the AUA Nephrolithiasis Guidelines Panel have demonstrated superior stone-free rates, improved complication rates and a reduced need for secondary procedure in those patients treated with PNL monotherapy. Combination techniques or SWL treatment may be benefical in patients with low-volume renal stone disease.*

***Conclusions:** Further advances in the PNL technique will not only increase stone-free outcomes and reduce post-operative complications, but also significantly reduce peri-operative patient morbidity. PNL monotherapy should be considered first line therapy for those patients with large or complex renal calculi.*

KEY WORDS: *PCNL; SWL; Staghorn stones.*

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INTRODUCTION

Over time, an untreated staghorn calculus is likely to destroy the kidney and/or cause life-threatening sepsis. Therefore, complete removal of the stone is imperative to eradicate any causative organisms, relieve obstruction, prevent further stone growth and any associated infection, and preserve kidney function. Thus, complete stone removal should remain the primary therapeutic goal, especially when a struvite/calcium carbonate/apatite stone is present.

There are four modalities that must be considered to remove staghorn calculi:

- percutaneous nephrolithotomy (PNL) monotherapy;
- combinations of PNL and shock-wave lithotripsy (SWL);
- SWL monotherapy; and
- open surgery – (typically anatrophic nephrolithotomy).

The following manuscript compares percutaneous nephrolithotomy to multimodal approaches for stone removal.

MATERIALS AND METHODS

Percutaneous nephrolithotomy

PNL is usually performed with the patient in a prone position and may be divided into two components, access and stone removal. To achieve percutaneous access a small hollow needle is placed into the kidney and a flexible guide wire is manipulated though the needle under fluoroscopic control into the kidney and down the ureter. Care is taken to choose the optimal port of entry into the kidney. Upper pole entry usually provides access to the majority of the collecting system and may allow complete removal of a staghorn stone through one site. However, two or more access sites may be required when the collecting system anatomy is complex.

Once access is achieved, the tract is dilated to 24 to 30 French with a balloon or coaxial dilators. Initial fragmentation is performed with a rigid nephroscope using an ultrasonic or pneumatic lithotrite, or with a lithotrite that combines both modalities. Sterile saline is used for irrigation. Flexible nephroscopy then is used to access stones that cannot be reached with the rigid nephroscope. Stone fragmentation is undertaken with a Holmium:yttrium-aluminum-garnet (YAG) laser or electrohydraulic lithotripsy, and fragments can be removed with flexible instruments. Historically, a 20 to 24 French nephrostomy tube has been placed at the end of the procedure. Some investigators have used smaller nephrostomy tubes in an attempt to reduce postoperative morbidity while others have advocated placing an internalized ureteral stent and not using a nephrostomy tube, so called "tubeless PNL".

Hospitalization is usually 1 to 4 days, and most patients resume normal activities 2 weeks after stone removal. Post-procedure tube management varies amongst urologists, with some removing all tubes within 24 to 48 hours and others discharging the patient from the hospital with a percutaneous tube that is removed 5 to 7 days later. Transfusion rates for PNL in treating staghorn calculi vary from 5 to 25%. Secondary procedure rates, ie, rates at which an instrument must be reinserted through the tract to remove residual stones, vary from 10% in simple situations to 40 to 50% for more complicated problems. Stone-free rates of 60 to 90% are achievable using PNL.

Combination percutaneous nephrolithotomy and shock wave lithotripsy

Alternatively, one can utilize both PNL and SWL for managing staghorn calculi. This approach combines the main advantages of the two techniques by using PNL to rapidly remove large volumes of stone and by using SWL to fragment stones that are difficult to access with PNL.

PNL is undertaken initially, and every effort is made to remove as much stone as possible before proceeding with SWL. Experience has demonstrated that passage of all fragments does not occur following SWL. Therefore, most studies recommend that the final procedure in combination therapy should be percutaneous nephroscopy. Yet, it is apparent that combination therapy is being used less frequently as a result of improvements in endoscopic and intracorporeal lithotripsy technology. Studies suggest that repeat PNL, or second-look nephroscopy through an established tract, may prove more efficient for complete stone removal than the combination approach. Some of the recent series have omitted the second-look PNL, and this change in technique likely accounts for the lower current stone-free rate compared to that reported in the original staghorn guideline document.

Shock wave lithotripsy monotherapy

SWL is commonly used to treat many patients with nephrolithiasis. The original lithotripter, the Dornier HM-3, still is utilized, but newer, second- and third-generation devices have been designed with variable power capabilities as well as tighter focal regions, which have resulted in less need for general or regional anesthesia during SWL administration. Yet, these smaller focal zones have resulted in inferior stone fragmentation as compared to the Dornier HM3 device. Moreover, the higher power density created by some of the second- and third-generation machines have been reported to increase the potential for postoperative complications including the incidence of clinically significant perinephric hematoma and need for transfusion.

SWL is widely available, and its noninvasive nature has much appeal. SWL monotherapy has disadvantages, however, in the management of patients with staghorn stones. In these patients, numerous studies have found that SWL is associated with a higher risk of residual fragments and a higher probability of unplanned procedures than PNL. In patients with staghorn calculi, such additional interventions as well as the need for multiple SWL procedures may make this approach more expensive than the other alternatives.

Recent in vitro animal and clinical studies suggest that the rate of shock-wave administration can influence stone fragmentation and resultant clearance of stone fragments. These studies have demonstrated that a slower shock-wave rate can significantly improve stone-free rates and may have application for SWL monotherapy in patients with staghorn calculi.

Results

As noted previously, most urologists would agree that the stone-free rate is the most meaningful determinate of the successful treatment of patients with staghorn stones. Using this criterion, results of meta-analyses demonstrate that, among the four treatments analyzed, an optimal outcome is most likely to be achieved with endoscopic or PNL-based therapy and least likely with SWL-monotherapy. Combination therapy yields intermediate stone-free rates, and most studies conclude that percutaneous nephroscopy should be the last part of any combination sequence as it allows for better assessment of stone-free status and a greater chance of achieving this state.

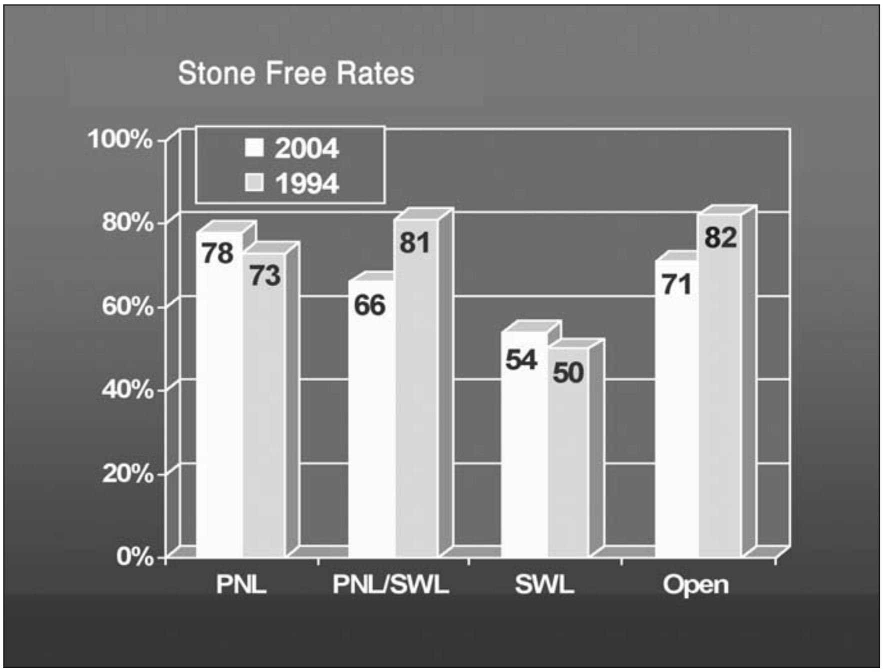
Meta-analytic estimates of stone-free rates (95% confidence intervals) from multiple studies are 78% (74-83%) for PNL, 66% (60-72%) for combination therapy, 54% (45-64%) for SWL, and 71% (56-84%) for open surgery. The fact that the 95% confidence interval for PNL does not overlap with those of either combination therapy or SWL supports recommendations that PNL should be the initial treatment utilized for most patients.

Discussion

PNL has emerged as the treatment of choice for the management of patients with staghorn calculi based on superior outcomes and acceptably low morbidity. Recent advances in instrumentation and technique have improved stone-free rates, increased treatment efficiency, and reduced morbidity thereby favoring PNL monotherapy.

Figure 1.

Stone free data from the 2004 Report from the AUA Nephrolithiasis Guidelines Panel.



SWL monotherapy can achieve significantly higher stone-free rates in patients with partial staghorn calculi as compared to those individuals with the stones filling the entire renal collection system. Moreover, the need for secondary procedures and post-operative complications are reduced substantially in patients with partial staghorn stones treated with SWL as compared to those with complete staghorn calculi.

SWL monotherapy for patients with staghorn calculi can result in significant postoperative complications, including steinstrasse, renal colic, sepsis, and perinephric hematoma.

Combination therapy (ie "sandwich" therapy: PNL-SWL-PNL) was recommended as the treatment of choice for patients with staghorn calculi by the original Nephrolithiasis Guidelines Panel in 1994 (Segura 1994), but there has been little uniformity in the literature with regard to what constitutes combination therapy. The original intent of this approach was to initiate therapy with percutaneous debulking, followed by SWL of residual stones, and finally percutaneous nephroscopy to retrieve the remaining fragments ("sandwich therapy"). In many cases, however, final percutaneous nephroscopy has been abandoned in favor of spontaneous passage of fragments, resulting in suboptimal stone-free rates in some series.

Currently, more aggressive use of flexible nephroscopy has resulted in less reliance on adjuvant SWL, improved stone-free rates, and fewer procedures per patient. Comparing PNL with combination therapy, the Panel found stone-free rates are higher with PNL (78% versus 66%, respectively) and that PNL requires fewer total procedures (1.9 versus 3.3, respectively); transfusion rates are similar for the two modalities (18% versus 17%, respectively).

With today's newer technologies, open surgery is rarely required to manage patients with nephrolithiasis. The current indications for open surgery in patients harboring staghorn calculi are extremely large stones, complex collecting system issues, excessive morbid obesity, or extremely poor function of the affected renal unit.

Some extremely obese individuals also may require this approach as their body habitus precludes fluoroscopic imaging and endoscopic maneuvering required for PNL.

The trend toward PNL monotherapy has been driven in part by the expanded role of flexible nephroscopy, better grasping devices and baskets, the holmium laser for intracorporeal lithotripsy, and also the use of multiple percutaneous access tracts. At the time of initial PNL, flexible nephroscopy is used after debulking the stone with rigid nephroscopy to remove stones remote from the percutaneous access tract. If residual stones are identified on post-PNL imaging studies, second-look flexible nephroscopy via the preexisting nephrostomy tract is used to retrieve residual stones. However, it also may be necessary to place other tracts in this setting to facilitate complete stone removal.

In addition to its role in retrieving residual calculi and achieving a stone-free state, flexible nephroscopy also may limit the need for additional percutaneous access tracts. Although initial stone debulking traditionally relied on ultrasonic energy, pneumatic lithotripsy likewise provides a rapid, efficient means of fragmenting stones. Recently, a combination device has been developed that incorporates ultrasonic and pneumatic lithotripsy in a single instrument in which the two modalities can be used simultaneously or alone. These devices have the potential to increase the speed and versatility of rigid nephroscopy.

Most recent investigations support the concept that percutaneous-based therapy should remain the mainstay for management of staghorn calculi. It appears that SWL monotherapy has a very limited role in the management of patients with complex renal calculi and should be reserved for use in pediatric patients or in low-volume staghorn calculi. The recent report from the combined EAU-AUA Nephrolithiasis Guidelines Panel suggests that

Conclusions

For the majority of patients with large and/or complex staghorn stones, PNL-based techniques are preferred because of their lower morbidity compared to open surgery. The only randomized, prospective trial comparing

PNL to SWL for staghorn stone management demonstrated stone-free rates with initial PNL to be more than three times greater than with SWL monotherapy. The mainstay of any form or combination or multi-modal therapy should be endoscopic removal. This approach allows removal of a high volume of stone as well as an accurate assessment of stone-free status. SWL may be utilized in cases where remaining stones cannot be reached with flexible nephroscopy or safely approached via another access tract. However, total removal of fragments from the collecting system after SWL without subsequent nephroscopy is unlikely. Extremely low stone-free rates have been reported for combination approaches where SWL was the last combination procedure. Therefore, percutaneous nephroscopy should be the last part of a combination therapy sequence as it allows for better assessment of stone-free status and a greater chance of achieving this state.

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PRESENTATION

Endoscopic combined intrarenal surgery for high burden renal stones.

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Summary

"High burden stones" include single or multiple large calculi (altogether surface area > 300 mm^2, or largest diameter > 20 mm), and staghorn calculi (any branched stone occupying more than one portion of the renal collecting system, i.e. pelvis with one or more calyceal extensions). Since clinically threatening, their active removal is mandatory. All updated guidelines recommend four modalities as potential treatment for large/staghorn urolithiasis, including PNL monotherapy, ESWL monotherapy, combinations of PNL and ESWL, and open surgery. The technical enhancement and increasing spread of PNL, ESWL and ureteroscopy in the past twenty years has led to displacement of the surgical therapy of renoureteral calculi in the daily urological practice (nowadays 1-5.4% of cases in developed countries and in well-equipped, dedicated centres), but open or laparoscopic management of urolithiasis is still a viable option that should be considered in few, highly selected circumstances.
Currently, PNL is the preferred first-line, minimally invasive treatment for complete one-step removal of high burden urolithiasis. It has been suggested that two or more access sites may be required for complete clearance, yet implying greater blood loss. The use of single-tract PNL with adjuvant procedures such as flexible ureteroscopy/nephroscopy may decrease the disadvantages of the multiple-tract PNL without compromising on stone-free rates. ECIRS (= endoscopic combined intrarenal surgery) is a new, versatile approach for the treatment of large and/or complex urolithiasis. Combining the anterograde and retrograde approach to the renal cavities, ECIRS allows the combined use of all the rigid and flexible endourological armamentarium, and optimal endovision percutaneous renal puncture, preliminary evaluation of renal stones features, negligible need of multiple percutaneous accesses, immediate treatment of concomitant ureteral calculi or ureteropyelic junction stenoses; final visual control of the stone-free status. ECIRS is usually performed in the Galdakao-modified supine Valdivia position, the only patient position supporting this comprehensive attitude of the urologist towards upper urinary tract pathologies. Optimal planning of a safe and effective ECIRS procedure also benefits from an accurate preliminary three-dimensional study by means of tomography urography of the pelvicalyceal anatomy (which is complex and often highly variable) and of the stone features (site, number, size).

KEY WORDS: *PNL; Ureteroscopy; Large stones.*

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"*High burden stones*" include single or multiple large calculi (altogether surface area > 300 mm^2, or largest diameter > 20 mm, according to EAU Guidelines 2008 for Urolithiasis), and staghorn calculi (any branched stone occupying more than one portion of the renal collecting system, i.e. pelvis with one or more calyceal extensions).
Over time, high burden stones will cause progressive renal deterioration, pyonephrosis, obstruction, flank pain, and/or life-threatening sepsis, therefore their active removal is mandatory.
All updated guidelines recommend four modalities as potential treatment for large/staghorn urolithiasis, including PNL monotherapy, ESWL monotherapy, combinations of PNL and ESWL (sandwich therapies), and open surgery, which should be part of the urologist's skills. Indeed, the technical enhancement and increasing spread of PNL, ESWL and ureteroscopy in the past twen-

ty years has led to displacement of the surgical therapy of renoureteral calculi in the daily urological practice (nowadays 1-5.4% of cases in developed countries and in well-equipped, dedicated centres). Open management of urolithiasis is still a viable option that should be considered in few, highly selected circumstances, involving difficult stone situations (in terms of hardness, size or location), abnormal anatomy of the urinary system, failure of ESWL, PNL, or retrograde ureteroscopic stone removal, environment (more cost-effectiveness in the face of limited resources in developing countries). The cases not amenable to minimally invasive procedures may also benefit from the less invasive laparoscopic surgery, increasingly used in situations for which open surgery would previously have been used (pyelocalycotomy, ureterolithotomy, anatrophic nephrolithotomy).
Currently, PNL is the preferred first-line, minimally invasive treatment for complete one-step removal of high burden urolithiasis. It has been suggested that two or more access sites may be required for complete clearance, yet implying greater blood loss. Since the aim of treating high burden stones is to achieve complete clearance of stone burden with minimal morbidity (namely, fewer complications, shorter hospital stay, and lower transfusion requirements), the use of single-tract PNL with adjuvant procedures such as flexible ureteroscopy/nephroscopy may decrease the disadvantages of the multiple-tract PNL without compromising on stone-free rates (1). Combined PNL and ureteroscopic retrograde management of complex renal calculi can reduce the number of percutaneous access tracts, which would otherwise be required, relocating stones in an unfavourable location relative to the access tract within easy reach of the single nephrostomy tract (2).
ECIRS (= *endoscopic combined intrarenal surgery*) is the new, versatile approach for the treatment of large and/or complex urolithiasis we developed during recent years in our centre. Combining anterograde (PNL) and retrograde (ureteroscopy) approach to the renal cavities, ECIRS allows the combined use of all the rigid and flexible endourological armamentarium, and optimal endovision percutaneous renal puncture, preliminary evaluation of renal stones features, negligible need of multiple percutaneous accesses, immediate treatment of concomitant ureteral calculi or ureteropyelic junction stenoses; final visual control of the stone-free status. We usually perform ECIRS in the Galdakao-modified supine Valdivia position, the only patient position supporting this comprehensive attitude of the urologist towards a variety of upper urinary tract pathologies (3). Optimal planning of a safe and effective ECIRS procedure also benefits from an accurate preliminary study of the pelvicalyceal anatomy (which is complex and often highly variable) and of the stone features (site, number, size), by means of multidetector computed tomography urography, multiplanar reconstruction and three-dimensional reformatting, with no significant increase in patient radiation burden. This pre-operative 3D imaging method should become standard for planning PNL/ECIRS treatment of high burden stones, making the unphatomable clinical difference from the first blind punctures performed only few decades ago.

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PRESENTATION

High burden stones: The role of SWL.

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Summary

Percutaneous nephrolitotomy (PCNL), PCNL and Shock Wave Lithotripsy (SWL), SWL monotherapy and open surgery are nowadays the potential treatment alternatives for patients with staghorn stones. Several groups have proposed classification schemes to better define staghorn calculi dimensions taking into account size, morphology and composition of the stones. More recently the use of a CT imaging with three-dimensional reconstruction or of a coronal reconstruction of axial CT images was reported to obtain an accurate stone volume calculation. The difficulty in accurately assessing stone burden explains the wide range of reported stone-free rates for SWL monotherapy from 22 to 85%. A recent AUA guideline of the management of staghorn calculi stated that stone free rate is 78% for PCNL and 54% for SWL monotherapy and these values are similar to those reported in Segura guideline but the rate for combination treatment (PNL+SWL) is now lower (66% versus 81%) than in the previous guideline. This reduction is probably due to the fact that in the recent meta-analysis SWL was the last procedure and in the previous generally a sandwich therapy was performed with PCNL followed by a SWL and a secondary PCNL. Improved PCNL techniques with use of flexible nephroscopy and multitract PCNL allow to achieve complete stone clearance by PCNL alone.

Complete removal of stone is crucial to eradicate infection and prevent further stone regrowth. Residual fragments may perpetuate postreatment infection and stone regrowth has been reported up to 78% in such patients after SWL monotherapy. In our previous experience (prior to 2000) we observed 45 pts with high burden stones: 31/45 pts (68%) underwent combined therapy PCNL and SWL with a successful rate of 65% (stone free and fragments < 4mm). In our more recent experience ('03-'08) we treated 34 patients with high burden stones: we performed combined therapy PCNL and SWL in 11 pts (32%) with an overall success rate of 63%. PCNL was undertaken initially with the attempt to remove as much stone as possible with the aid of flexible nephroscopy and SWL was used only for residual stones because the passage, even of fragments < 4mm, does not always occur in dilated renal cavities. SWL monotherapy should not be used for most patients and may be considered only in patients with small volume staghorn stones with normal collecting system.

KEY WORDS: *Shock wave Lithotripsy; Percutaneous nephrolithoromy; Staghorn stones.*

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INTRODUCTION

In the seventies open surgery, with anatrophic nephrolithotomy, was the treatment of choice for patients with struvite stones and the stone free rate was about 85% (1). Percutaneous nephrolitotomy (PCNL), PCNL and *Shock Wave Lithotripsy* (SWL), SWL monotherapy and open surgery are nowadays the potential treatment alternatives for patients with staghorn stones.

Several groups have proposed classification schemes to better define staghorn calculi dimensions (2-5) taking into account size, morphology and composition of the stones. More recently the use of a CT imaging with three-dimensional reconstruction (6) or of a coronal reconstruction of axial CT images (7) was reported to obtain an accurate stone volume calculation. The difficulty in accurately assessing stone burden explains the wide range of reported stone-free rates for SWL monotherapy from 22 to 85% (5).

SHOCK WAVE LITHOTRIPSY AND PERCUTANEOUS STONE REMOVAL

When the stone burden as measured by stone surface area was used, overall stone free rate for SWL monotherapy was 51.2% and only 22.2% when stone surface area exceeded 1000 mm^2. In the group treated with initial PCNL with or without SWL the overall stone free rate was 84,2% and 82,4% respectively; whereas complications were more common in SWL monotherapy group (30.5%) (5). *Meretyk* (8) reported an overall stone free rate of 22% for SWL monotherapy and 15% of septic complications compared with 74% and 2% respectively for PCNL group. The Authors concluded that PCNL followed by SWL, if needed, is superior to SWL monotherapy in the treatment of patients with staghorn stones. *Streem* (9) described as sandwich therapy a primary percutaneous stone debulking followed by SWL of any caliceal residual stone and, after SWL, a final secondary percutaneous procedure. A recent AUA guideline (10) of the management of staghorn calculi stated that stone free rate was 78% for PCNL and 54% for SWL monotherapy and these values are similar to those reported in Segura (11) guideline but the rate for combination treatment (PNL+SWL) success was lower (66% versus 81%) than in the previous guideline. This reduction is probably due to the fact that in the recent meta-analysis SWL was the last procedure and in the previous generally a sandwich therapy was performed with PCNL followed by a SWL and a secondary PCNL.

Improved PCNL techniques with flexible nephroscopy multitract PCNL allow to achieve complete stone clearance by PCNL alone (12). *Marguet* (13) reported the simultaneous use of flexible ureterorenoscope and PCNL to avoid the need for multiple percutaneous access for complex and branched renal stones.

The combination of SWL and flexible ureteroscopy was reported for the treatment of large renal stones in patients unsuitable for PCNL with an overall stone free rate of 77% (defined as fragments < 4 mm) (14).

Complete removal of stone is crucial to eradicate infection and prevent further stone regrowth. Residual fragments may perpetuate postreatment infection and prpmote stone regrowth that has been reported in up to 78% of patients after SWL monotherapy (15-17). In our previous experience we observed 45 patients with high burden stones: 31/45 patients (68%) underwent combined therapy PCNL and SWL with a successful rate of 65% (stone free and fragments < 4 mm). In our more recent experience ('03-'08) we treated 34 patients with high burden stones: we performed combined therapy PCNL and SWL in 11 pts (32%) with an overall success rate of 63%.

Conclusions

In our experience PCNL was undertaken initially with the attempt to remove as much stone as possible with the aid of flexible nephroscopy and use SWL only for residual stones because the passage, even of fragments < 4 mm, does not always occur in dilated renal cavities. PCNL should be the first treatment used for most patients with struvite stones.

SWL monotherapy should not be used for most patients and may be considered only in patients with small volume staghorn stones with normal collecting system.

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PRESENTATION

Stone treatment in children: Where we are today?

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Summary

Objective: Stone disease in children differs in pathogenesis, presentation and in treatment from adults. In recent years, big changes on its management have occurred. We reviewed our experience on upper tract urinary calculi in paediatric age.
Material and Methods: Patients observed for upper tract urinary stones from June 2002 to June 2008 were reviewed. Bladder-urethral calculi were excluded. Presenting symptoms had a wide range: macro- or micro-hematuria, recurrent abdominal or flank pain, or non-specific symptoms such as irritability and failure to thrive.
Renal and urinary tract ultrasonography, plain abdomen X-ray were performed in case of suggestive symptoms. Spiral CT without contrast was recommended to better define the stone disease. Metabolic evaluation is mandatory for any child presenting history of urinary calculi or nephrocalcinosis. Idiopathic hypercalciuria has been recognized as predominant ethiological factor of paediatric nephrolithiasis, excluding stones correlated with urinary tract malformations (up to 45%).
Results: In a 6-year period, 232 patients, aged 19 months to 18 years, were treated: 195 children (60.8%), mean age 8.3 years, underwent ESWL. Re-do treatments were 233 (2.3 ESWL/patient), with 77% stone free rate. Percutaneous nephrolithotomy (PCNL) was adopted in 33 patients, mean age 13.4 years, with 2 re-treatments. Stone clearance was 74% after single treatment, increased to 88% by secondary ESWL. Blood transfusion was needed in 7 cases (16%). Retrograde ureterolithotripsy (ULT) was performed in 96 patients presenting ureteral stones, for a total of 99 procedures. Stone free rate was 99%, as 1 pushed up stone required subsequent ESWL. No ureteral perforation or other significant complications occurred. Medical treatment was offered as ancillary therapy or to prevent recurrences, according to the metabolic results and the stone biochemistry.
Conclusions: Stone treatment in children is changing dramatically, thanks to progressive transfer of procedures from adult patients and recent advances in miniaturized new technologies. Surgical approach to renal and urinary tract stones in childhood was recently moving from open surgical procedures (nephrolithotomy, ureterolithotomy, cystolithotomy), to less invasive procedures, such as ESWL and endoscopic approaches, as ULT and PCNL. Mini-invasive procedures present high efficacy and safety, also in young children, but require appropriate instrumentation and specific experience.

KEY WORDS: *Stones; Children; Endourology; ESWL.*

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INTRODUCTION

Urinary tract stones in children are uncommon, representing 0.1% to 5% of urolithiasis in adult age (1). Significant changes of epidemiology have been observed in developed ountries, presenting a dramatic reduction of bladder stones, nowadays limited to augmented or exstrofic bladders with chronic bacteriuria and urine residual. On the contrary, upper tract lithiasis and nephrocalcinosis seem to present increasing prevalence in children, especially in young infants or in premature babies.

In paediatric age, renal and urinary tract stone disease differs significantly from adult patients, regarding pathogenesis, presentation and treatment. Moreover, with recent advances in technology and miniaturization of endourological approaches, stone management in children has changed in the last few years, from an open surgical approach as the only possible one, to less invasive procedures, such as ESWL and endoscopic techniques (ULT, PCNL), also in infants and children younger than 5 years of age (2). We revisited our recent experience on reno-ureteral stone patients in paediatric age, observed at our Institution in the last 6 years, regarding pathogenetic factors, presenting symptoms, treatment options and results.

Material and methods

The records of all patients in paediatric age (up to 18 years of age) treated for kidney and/or ureteral stones at our Institution from June 2002 to June 2008 were retrospectively reviewed. Lower urinary tract stone patients were excluded.

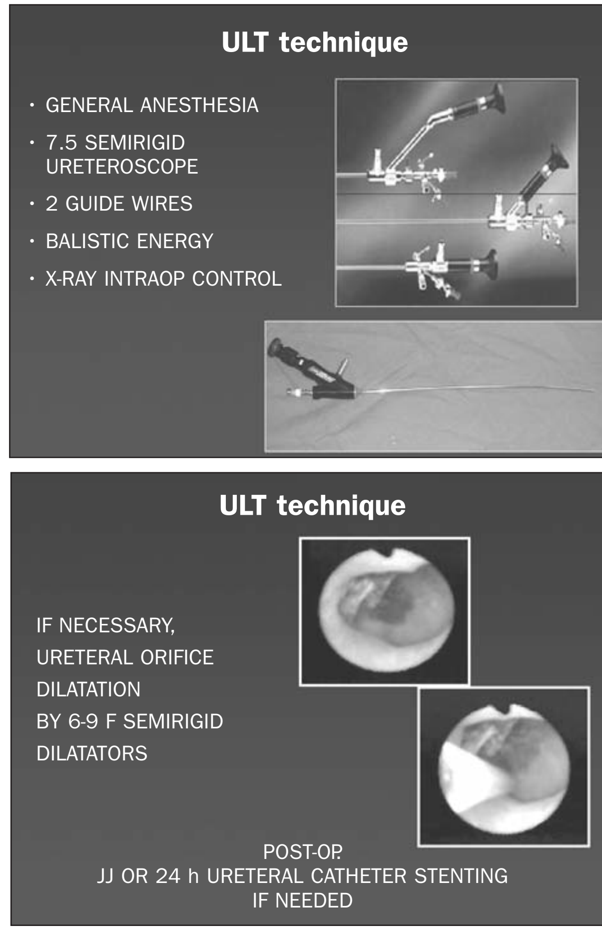
Metabolic study on 24 hour urine output (cystinuria, calciuria, citraturia, oxaluria), and morphological examinations (urinary tract ultrasound, plain abdomen X-ray and intravenous pyelogram or CT scan, if requested, were performed. Urine cultures were obtained, and detected UTI's were treated before any stone treatment.

A complete range of therapeutical options were offered, from open surgical approaches to ESWL, endoscopic procedures (ULT or PCNL), and medical treatment. The adopted techniques for ESWL, ULT and PCNL were previously described (1, 3, 4). ESWL was performed by the Edap Sonolith 4000® lithotripter, with real time ultrasound system of tracking. The mean energy used was 450,000 (330,000-694,000) k-joule with 2,500 (1,900-3,500) shock waves. We used a 24F tract by Amplatz dilatators, with a 22F nephroscope for the PCNL procedure, in the majority of our cases. The 7.5F and 6.5F ureteroscopes were utilized under general anesthesia for retrograde ULT (Figure 1A-B). Ballistic energy by 1.9F probe (Lithoclast®) and Holmium-Yag laser by 400 micron fibers were used for lithotripsy, and different graspers or baskets for extraction.

Complex calculi were defined as either staghorn or those with a stone bulk larger than 300 mm^2, or involving more than one calyx or the upper ureter, or finally stones in abnormal kidneys (5).

Patients were evaluated at 3 and 6 months from their completed treatment by ultrasound and plain X-ray, if needed. Success was determined as completely stone-free or with clinically insignificant residual fragments on plain abdominal X-ray (largest diameter of the residual fragments < 3 mm).

Figure 1A-B.
ULT technique at our Institution. A: scopes.
B: ureteroscopic lithotripsy in mid ureter stone.



Results

We observed 321 patients, aged 19 months to 17 years (mean age 9.7 years), presenting upper tract stones (male/female ratio 2.3:1). Complex calculi were present in 56 children (18%), 80% in males. Presenting symptoms were abdominal pain in 56% of cases, hematuria in 22%, recurrent UTI's in 45% (often, more than a single symptom was present at debut). In 17% of our children, urinary stones were diagnosed incidentally.

ESWL were adopted in 195 children (60.8%), aged 2 to 18 years (mean age 8.3 years). The total number of treatments were 428, (mean 2.3 sessions per patient). The mean calculi diameter was 15 mm (5 mm to 24 mm). Double-J 4.7F ureteral stent was positioned before ESWL if the stone diameter was more than 13 mm or in a single functioning kidney.

Table 1.
Urological treatment on 321 children presenting upper urinary tract stones.

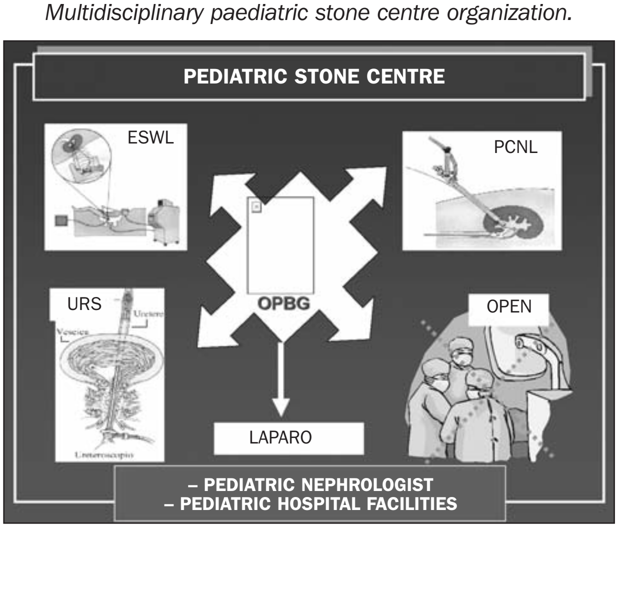
Treatment modality	ESWL	PCNL	ULT	Open surgery
N° pts	195	33	96	0
%	60.8	10.4	29.8	
Mean age (years)	8.3	13.4	7.8	–
Mean ∅ stones (mm)	15	28	12	–
Range ∅ stones (mm)	5-24	13-38	5-19	–
Total number procedures	428	35	99	–
Re-do treatments	233	2	3	–
Stone free rate (%)	77	74	99	–
Stone free in dual therapy	–	88	–	–
Severe complications	–	–	–	–
Blood transfusion	–	7 (16%)	–	–

The treatment was performed without general anesthesia in 32% of the cases, usually in older children. The stone free (or insignificant residual fragments) rate was 77%. No significant complications were observed (Table 1).
PCNL was performed in 33 patients (10.4%), aged 7 to 16years (mean age 13.4 years), for a total of 35 procedures. The mean stone diameter was 28 mm (13 to 38 mm). Complex calculi were present in 17 patients (48% of the PCNL procedures). Stone free or non-significant residual fragments rate was obtained in 74% as single therapy, risen up to 88% after ancillary ESWL sessions. No open surgery conversion was needed. Blood transfusion was necessary in 6 procedures (17%).
Retrograde ULT was adopted in 96 patients (29.8%), 19 months to 16 years old (mean age 7.8 years): in 3 cases the procedure was repeated, for a total of 99 ULT. The mean calculi diameter was 12 mm (5 mm to 19 mm), and its position was distal ureter in 82%, middle ureter in 7% and proximal ureter in 11%. A indwelling ureteral catheter or a double J stent was left for 1 to 20 days after the endoscopic procedure in 69 children (74%). No bilateral synchronous ULT was performed. Stone free patients were 95 (99%), as in 1 case the stone was pushed up in the lower calyx and treated subsequently by ESWL. No significant urological complications were observed.
No open surgical lithotomy was performed in the study group of patients.

Discussion

Stone disease in children is underestimated and it differs in presentation and treatment (2, 4, 5). The prevalence in Italy seems to be increasing in the last decade. Predisposing factors, as metabolic or genetic disorders and associated urinary tract malformations may play a significant role.
Metabolic work-up is necessary in any infant or child presenting kidney stone or nephrocalcinosis, as hypercalciuria, cystinuria and other metabolic disorders may be a common cause of urolithiasis already in the young children and infants.

Figure 2.
Multidisciplinary paediatric stone centre organization.



Treatment of renal and upper tract stone disease is changing in paediatric age due to better metabolic, genetic and nephrological knowledge and to significant advances in technology and miniaturization of urological instruments.
Stone management has dramatically changed from open surgical approaches to less invasive procedures, such as ESWL, PCNL and ULT. ESWL is considered as first choice method for managing the majority of pyelocalyceal stones in children (1) with low complications rate. We obtained 77 % stone free or insignificant residual fragments rate, with little related complications in the present series of 195 children.
PCNL is the treatment of choice in children with complex renal calculi or in ESWL-resistant renal stones, as cystine stones. In adult population, PCNL has progressively replaced open surgery, in almost all renal calculi. In paediatric patients, careful manipulation during surgical manoeuvres and precise percutaneous access to the selected calyx are needed, to prevent hemorrage (4). The clearance rate of PCNL in children is reported from 70% up to 90% , as single or dual therapy (4). On 33 patients (50% complex calculi), our clearance rate was 74% as single therapy and 88% if associated with ESWL, and blood transfusion was needed in 7 procedures (16%). Nowadays, PCNL has become feasible for larger stones and in younger children, although it requires smaller instruments and special caution because of the delicate anatomical structures. It should be considered as the treatment of choice for complex calculi or abnormal kidneys in children.
ULT has been proved as effective for ureteral stones, also in children younger than 3 years of age, thanks to endoscopes miniaturization. We had excellent results by 99 ULT performed on 96 children (youngest patient 19 months old). The stone free rate was very high (99%) and no ureteral perforation or other significant complications occurred. In our opinion, ULT should be the first line therapy in children ureteral calculi (3, 6).

Conclusion

Stone disease is uncommon in paediatric age, but it appears with increasing prevalence and often needs technically challenging urological procedures. The goals of the nephro-urological treatment in paediatric population are to achieve maximal calculi clearance, to minimize morbidity and hospitalization, to preserve renal function and to prevent recurrence. With the advent of ESWL and continuing advances in endoscopic technologies, the treatment options for renal and ureteral stone is changing dramatically in children. Open surgical procedures should be abandoned or limited to very uncommon situations.
In absence of paediatric guidelines, the appropriate treatment modality should be selected for any single case. Complete instrument availability and specific expertise in paediatric endourology and nephrology are needed, in a coordinated multidisciplinary "Paediatric Stone Center" (Figure 2), offering the necessary facilities to the child.

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PRESENTATION

Extracorporeal shock wave lithotripsy for the treatment of urinary stones in children.

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Summary

***Objective:** To provide the reader with an overview about the role of shock wave lithotripsy (SWL) in the management of urinary stones in children, and the complications associated with the procedure.*
***Material and methods:** We performed a non-systematic review of the English literature to ascertain the success rate of SWL, the need for ancillary procedures such as stenting of the urinary tract or endoscopic manipulation, and the possible side effects and complications of the procedure.*
***Results:** Both renal and ureteric stones can be amenable to SWL. The latter can be performed in patients of any age including low birth weight infants. Paediatric series of SWL report 3-month stone-free rates of 70 to 100%. High rates can be achieved also dealing with large stones of 20-30 mm in diameter, staghorn calculi and stones located in the lower-pole. Current data seem to suggest that systematic preoperative insertion of ureteric stents is unnecessary. After the procedure, complications occur in about 20% of cases and include haematuria, steinstrasse, ureteric obstruction, and urinary tract infection with or without fever. Most of these complications are self-limiting and require only medical treatment. Haematoma formation is exceptional after SWL and the procedure does not seem to damage long-term renal growth and function, or cause any damage to the surrounding anatomical structures.*
***Conclusion:** Data from current literature warrant an attempt of treatment of urinary stones by SWL in many paediatric cases including very young patients, patients with big stones or stones in lower-poles, and patients with staghorn calculi. The procedure seems to be safe.*

KEY WORDS: Urolithiasis; Lithotripsy; Children.

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INTRODUCTION

Urinary stones have been reported to affect 0.1 to 5% of children and to account for up to 1 in 1000 hospital admissions. Due to the high compliance of the urinary tract, children are considered to pass stones more easily than adults. This warrants an initial conservative management of many paediatric cases with stone disease and a more liberal use of extra-corporeal shock wave lithotripsy (SWL) in children than adults. We aimed here to review the success rate of SWL, the need for ancillary peri-operative procedures such as stenting of the urinary tract or endoscopic manipulation, and the possible side effects and complications of the procedure.

MATERIAL AND METHODS

We performed a non-systematic review of the English literature in June 2008 via the databases MEDLINE/PubMed and EMBASE using the Medical Subjects Headings (MeSH) "urolithiasis" and "child" retrieved from the MeSH browser provided by MEDLINE.
Outcomes assessed included success rate of SWL, need for ancillary procedures such as stenting of the urinary tract, and possible side effects and complications of the procedure.

RESULTS

Both renal and ureteric stones in patients of any age can be amenable to SWL. The procedure can generally be performed with the patient under sedation. Indeed, the most severe complications reported after SWL were actually related to the general anaesthesia including laryngospasm and haemoptysis.
Ultrasound focusing is usually possible for renal stones,

whereas ureteric stones require fluoroscopic focusing. Number of shock waves should be individualized according to patient weight, and stone size and composition. Differences might also be related to the shock waves generator.

Paediatric series of SWL report stone-free rates 3 months after treatment between 70 and 100%. High rates have been reported even with big stones of 20-30 mm in diameters, staghorn stones, and stones located in the lower-pole. These cases, however, might require multiple treatment sessions.

Current data suggest that systematic preoperative ureteric stents insertion is unnecessary.

After SWL, complications occur in about 20% of cases. Major complications include haematuria, steinstrasse, ureteric obstruction, and urinary tract infection with or without fever. Steinstasse occurs in 6 to 20% of cases. Spontaneous stone clearance is common despite the small ureteric diameter. Therefore, expectant management with close follow-up is adequate. Alpha-blockers can be added to enhance stone clearance from the distal ureter. Haematuria and haematoma formation are exceptional after SWL and do not require any treatment. Urinary tract infection may follow stone fragmentation or overlap other complications such as steinstasse formation.

The procedure does not seem to cause any damage to the surrounding anatomical structures, such as the ovaries, during treatment of distal ureteric stones in female patients. SWL does not seem to affect long-term renal growth, ispilateral or total glomerular filtration rate, or differential renal function, as evaluated by dimercaptosuccinic renal scans. Consistently, SWL in paediatric patients does not seem to be associated with an increased long-term risk of hypertension, diabetes mellitus, renal failure, or proteinuria. Intuitively, type of SWL generator, shock wave numbers and dosage, on one side, and patient age, on the other, might affect the outcome, but data are still too limited to draw conclusions about these variables.

Discussion

This overview supports the principle that SWL is a viable option in the treatment of upper urinary tract stones in children. SWL has a nearly 100% success rate with stones < 20 mm, not located in the lower pole, and other than staghorn. Although SWL has been used also in these instances, percutaneous nephrolithotomy has been proposed as an alternative to increase stone-free rates and reduce complications. This approach appears to be increasingly reasonable with miniaturization of instruments and after the introduction of holmium laser technology. Nevertheless, percutaneous nephrolithotomy is also a more invasive approach, that does not ensure a 100% stone-free rate, can be associated with significant morbidity (20% haemorrhage), and increases hospital stay. Similar arguments apply to the use of ureteroscopy that has been recommended by some as an alternative for ureteric stones > 10 mm, but may be associated with significant complications such as ureteric perforation and stricture.

Conclusions

Data from current literature warrant an attempt of treatment of urinary stones by SWL in many cases including very young patients, patients with big stones or stones in lower-poles, and patients with staghorn calculi. The procedure seems to be safe.

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PRESENTATION

Percutaneous nephrolithotripsy (PCNL) in children: Experience of Parma.

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Summary

19 Percutaneous nephrolithotripsy procedures were done in 15 children aged from 8 months to 16 years with complex renal stones and/or extracorporeal shock wave lithotripsy refractory stones. The percutaneous techniques were done with the instrument and position (prone and supine) used in adults. 14/15 patients were stone-free (13 pts in one time, 1 pt in 2 procedures and 1 pt, with complex bilateral stones disease, in 5 endourological sessions). No relevant complications developed: 1 patient need a blood transfusion and 1 a temporary indwelling catheter for colic pain due to oedema. We believe that in children the endourological approach is better than traditional open surgery or reiterated extracorporeal shock wave lithotripsy sessions which often need anaesthesia and can not guarantee a complete clearance of the stones.

KEY WORDS: *Percutaneous nephrolithotripsy; Children; Supine position.*

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INTRODUCTION

Paediatric percutaneous nephrolithotripsy is a not frequent procedure due to the low incidence of stone disease in this age, but the endourological procedure (ureterolithotripsy/percutaneous approach) are considered as the first choice for several stone diseases when ESWL is not effective or contraindicated, bearing also in mind that these patients are exposed to an high incidence of lithiasic recurrences and surgical treatments. Nowadays, the improvement of mini-instruments and new lithotripsy sources (e.g. LASER) allows a less invasive procedure, less X-ray exposure with an excellent stone-free rate patients.
We report our experience on percutaneous procedures in paediatric age.

MATERIAL AND METHODS

From 2001 to June 2008, we performed 19 percutaneous approaches in 15 pts (10 female and 5 male); age-range: 8 months-16 years, with a mean age of 8,3 ± 4,9 yrs. The mean stone burden was 31 ± 10,3 mm (range: 18-45 mm) (Table 1). Two patients presented with bilateral complex lithiasis; 1 had a complete duplicity of the upper urinary tract; 1 had an horsekidney, 1 was affected by spinal cord disease and had been previously operated of enterocistoplasty and bilateral ureteral reimplantations; 1 presented with nephrocalcinosis (*Fanconi's syndrome*); and 2 cases after unsuccessful extracorporeal renal lithotripsy.
In 10 procedures a 14 Fr renal access was performed, in 7 cases a 20 Fr and in 2 cases a 30 Fr, respectively. The first 10 percutaneous approaches were performed in prone position, subsequently we changed our percutaneous surgical standard (4/2004) using the supine position (9), both in adult and children. In children older than 2 years the supine percutaneous position allows frequently the contemporaneous use of flexible uretheroscopy (positioning as first step) for the selection of

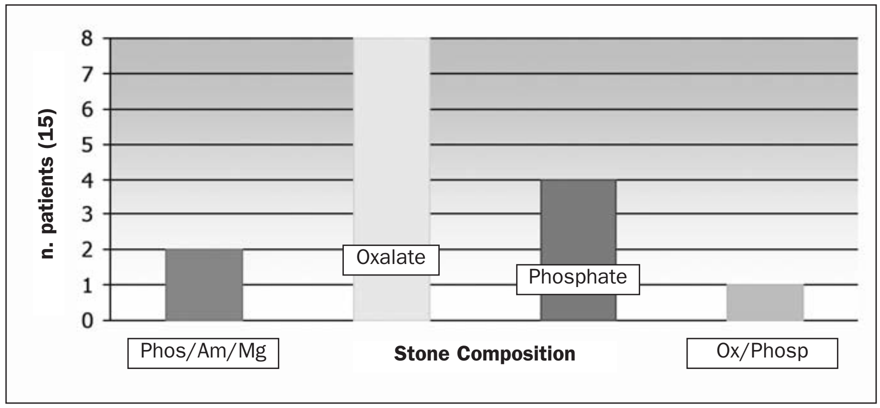
Table 1.
Stone Distribution.

Complex Lithiasis (2)	**Single Lithiasis** (6)	**Multiple Lithiasis** (7)
2	Pielic (4)	Pielic/Calix (4)
(1 bilateral)	UPJ (2)	Pielic/Calix/Ureteral (3)

the right calyx for the percutaneous puncture (Endovision° procedure).

The direct control of needle's perforation of renal papilla confirms or excludes the correct biplanar x-ray guidance and allows also a shorter X-ray exposure time during the construction of the percutaneous nephrostomy access. In 7/9 patients an Endovision° procedure was successfully carried on. LASER and ballistic probes were used for lithotripsy. In 6 cases a 12 Fr nephrostomy drainage was left in place at the end of the procedure, in 7 patients a 16 Fr and in 2 patients a 20 Fr, respectively. In 4 cases we performed a tubless procedure.

Figure 1.
Stone composition.



RESULT

14/15 patients were stone-free (13 pts in one time, 1 pt in 2 procedures and 1 pt, with complete bilateral stones disease, in 5 endourological essions). Stone composition was: phosphate ammonium and magnesium in 2 cases, oxalate in 8, phosphate in 4 and phosphate-oxalate in 1 patient (Figure 1). Generally, the ureteral mono-J was removed 24 hours posteperatively and the nephrostomy tube after an average of 4,7 ± 2,7 days (range: 2-11 days). Complications were: 1 prolonged haematuria from the nephrostomy tube needing a blood transfusion, 4 cases of fever, in 1 case pain secondary to oedema of the ureteral meatus that requested the application of an ureteral stent.

DISCUSSION AND CONCLUSION

In adults as in children, the supine position carries several advantages: optimal decubitus can be assumed by the awake patient by himself, no risk of traumatisms due to bed-position (standard prone procedure); no thoracic compression, reduced colon perforation risk; contemporary antegrade and retrograde access to the urinary tract. Retrograde ureteroscopy and antegrade percutaneous nephroscopy with rigid and flexible instruments (1), make clearance of stone fragments easier, even in very difficult cases and reduce also the necessity of multiple renal accesses and secondary procedures (e.g. extracorporeal lithotripsy on residual fragments). During LASER lithotripsy, the irrigation through the ureteral way allows the clearing of the stone fragments for gravity through the nephrostomy and maintains low intrarenal pressures during surgical time. When it's possible tubless procedure is preferred for less discomfort in postoperative time.

It's important to consider that in children even a minor blood loss could be engaging. Nevertheless, we believe that percutaneous nephrolithotripsy in paediatric age, if correctly performed, is a safe, effective and feasible procedure (2). And it is less invasive compared to open surgery (3).

Our take home message is that we believe that the endourological approach is better than traditional open surgery or reiterated extracorporeal shock wave lithotripsy sessions which often need anaesthesia and can not guarantee a complete clearance of the stones.

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PRESENTATION

Flexible ureteroscopy for kidney stones in children.

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Summary

Endoscopic evaluation and management of different pathological conditions involving the upper urinary tract using rigid or flexible endoscopes, is now readily feasible and has been shown to be safe and efficacious even in the smallest children.Paediatric ureteroscopic procedures are similar to their adult counterparts, so that basic endoscopic principles should be observed.
Aims of the management should be complete clearance of stones, preservation of renal function and prevention of stone recurrence.
In order to select the most appropriate surgical treatment, location, composition, and size of the stone(s), the anatomy of the collecting system, and the presence of obstruction along with the presence of infection of the urinary tract should be considered.
Although extracorporeal shockwave lithotripsy (ESWL) is still the most important procedure for treating urinary stones, advances in flexible endoscopes, intracorporeal lithotripsy, and extraction instruments have led to a shift in the range of indications.
According to the location of the stone the treatment can be done with the rigid or flexible ureteroscope.
To obtain stone fragments is essential for biochemical analysis. The stone composition may give significant information to prevent the high rate of recurrence, with dietary modification and specific therapy.
Successful outcomes for the retrograde treatment of renal calculi are similar to the ones obtained in the adult population (stone free rate 91-98%).
The retrograde semirigid and flexible ureteropyeloscopy, using a small calibre ureteroscope, are a valuable technique for kidney stones treatment in children. With excellent technique and meticulous attention to details, the significant complications are rare.

KEY WORDS: *Urinary calculi; Flexible ureteroscopy; Children.*

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Endoscopic evaluation and management of the different pathological conditions involving the upper urinary tract using rigid or flexible endoscopes, are now readily feasible and has been shown to be safe and efficacious even in the smallest children.
Reduction in size of the endoscopes, improvements in electronic imaging systems, proliferation of ancillary equipment and improvement in endourologic skills among paediatric urologists make endoscopic treatment of paediatric urolithiasis the treatment of choice.
Paediatric ureteroscopic procedures are similar to their adult counterparts, so that basic endoscopic principles should be observed (1).
Nevertheless, children pose specific technical challenges that require accurate planning before endoscopy and that affect the risks and outcomes of these procedures.
Aims of the management should be complete clearance of stones, preservation of renal function and prevention of stone recurrence. In paediatric patients with urinary stones, metabolic abnormalities conditions have been demonstrated in up to 50% of cases whereas a variety of anatomic anomalies have been found in about 30% of children with urolithiasis. For this reason in addition to stone removal procedures, treatment of paediatric urolithiasis requires a thorough metabolic and urological evaluation on an individual basis (2).
In order to select the most appropriate surgical treatment, location, composition, and size of the stone(s), the anatomy of the collecting system, and the presence of obstruction along with the presence of infection of the urinary tract should be considered.
Improvements in technology and growing experience have resulted in greater acceptance of minimally invasive techniques for the management of paediatric stones and

Table 1.
Indications for retrograde treatment of renal stones in children

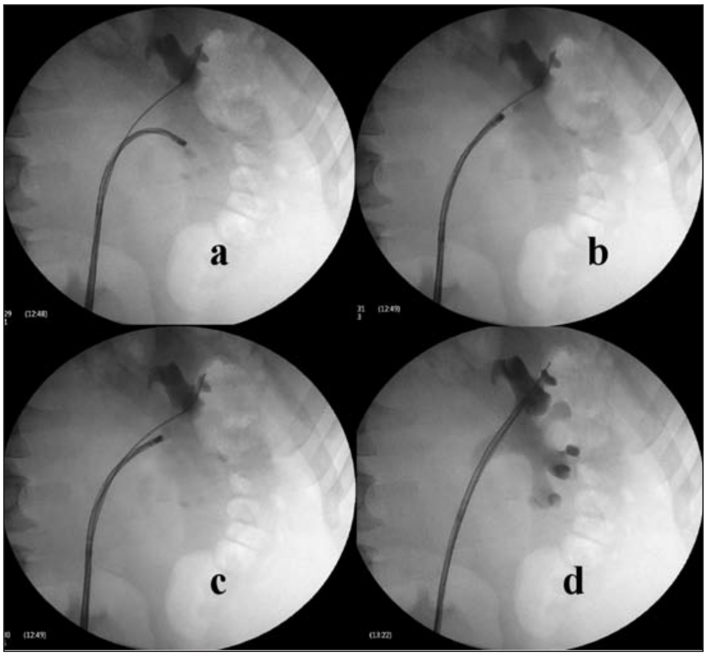
Stone size	≤ 2 cm
Stone composition	Refractory to ESWL
Stone location	Inferior calyx (lower pole)
Age	≥ 12 mth
Congenital anomalies	Absence of upper obstructive pathologies
Secondary anomalies	Solitary kidney Coagulation disorder Ectopic kidney

currently urologists can benefit from the whole spectrum of stone management alternatives also in children.
Although ESWL is still the most important procedure for treating urinary stones, advances in flexible endoscopes, intracorporeal lithotripsy, and extraction instruments have led to a shift in the range of indications (3).
The indications for retrograde treatment of the renal stone in child are showed in Table 1.
According to the location of the stone the treatment can be done with the rigid or flexible ureteroscope. The safety and efficacy of ballistic or holmium:YAG laser lithotripsy make intracorporeal lithotriptor the treatment of choice.
Usually, a paediatric cystoscope is used to place a 5 Fr open-ended catheter to the level of the intramural ureter, and a low pressare ureteropyelogram is taken. A 0.035 inch guidewire is positioned in the renal pelvis through the open-ended catheter and used as a safety wire during the procedure and for placing a ureteral catheter at the end of the procedure.
The second dual flex guidewire is advanced in the ureter through the working channel of the 6 or 8 Fr semirigid ureteroscope. The scope is then advanced between the two guidewires under endoscopic guidance up to the kidney.
This manoeuvre allows an active dilation of the ureter facilitating a subsequent flexible ureterorenoscopy or fragments removal. Any difficulty in negotiating the ureteric orifice was resolved by rotating the instrument atraumatically by 180° during insertion. Ureteric dilators were very rarely used and only when the meatus was impossible to negotiate.
Current ureteroscopic intracorporeal lithotripsy devices and stone retrieval technology allow for the treatment of calculi located throughout the intrarenal collecting system. If the stone is located in the upper calyx, middle calyx or in the renal pelvis a lithotripsy with a semirigid ureteroscope is recommended to start. Lower pole calculi are fragmented with a 200µ holmium laser fiber by a 7.5F flexible ureteroscope.
For those patients in whom the laser fiber reduces the scope deflection, precluding a re-entry into the lower pole calix, a 1.5, 1.9 or 2.2 tipless nitinol basket is used to displace the lower pole calculus into a more favorable position, allowing easier fragmentation (relocation technique) (4).
This manoeuvre is essential to preserve the ureterorenoscope (Figure 1).
The use of a ureteral access-sheath, during a flexible ureterorenoscopy, is suggested to improve the irrigant flow and visibility.
The ureteral access-sheath can induce transient ureteral ischemia and promote an acute inflammatory response, but it also prevents potentially harmful elevations in intrarenal pressure reducing the risk of urosepsis. It has also has the potential to improve stone-free rates by allowing passive egress or active retrieval of fragments.
To obtain stone fragments is essential for biochemical analysis. The stone composition may give significant information to prevent the high rate of recurrence, with dietary modification and specific therapy.
Usually, a ureteral open-ended catheter is left in place and removed in the next 24-72 h. If ureteric dilation was used or the procedure has been complicated, a double-pigtail ureteric stent is left in place for 1 week.
Successful outcomes for the retrograde treatment of renal calculi are similar to the ones obtained in the adult population (Table 2).
The retrograde semirigid and flexible ureteropyeloscopy, using a small calibre ureteroscope, are a valuable technique for kidney stones treatment in children. With excellent technique and meticulous attention to details, the significant complications are rare. Reported complications are infrequent and generally minor. Intra-operative ureteric injuries usually consist of ureteric perforation with the guide-wire.

Table 2.
Stone free rate in ureteroscopic treatment of kidney stones in child.

Cannon GM (J Endourol 2007) (5)	93% for stone < 15 mm 33% for stone > 15 mm	No relocation technique
Smaldone MC (J Urol 2007) (6)	91%	Mean stone size 8.3 mm
Minevich E (J Urol 2005) (7)	98%	Non stone size evidence

Figure 1.
Relocation technique. Fluoroscopic sequence (a, b, c, d) of a stone relocation in a more comfortable calyx.



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PRESENTATION

Indications, prediction of success and methods to improve outcome of shock wave lithotripsy of renal and upper ureteral calculi.

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Summary

***Objectives:** To clarify the current indications, factors influencing outcome and methods to predict and improve the results of shock wave lithotripsy for the treatment of renal and upper ureteral calculi.*
***Material and methods:** English literature on the Medline and MeSH databases was reviewed. Key words used for search included shock wave lithotripsy, calculi, stones, renal, kidney, ureter, efficacy, prediction, improvement and guidelines.*
***Results:** Shock wave lithotripsy still has certain indications for renal and upper ureteral stones. Major impact on outcome has the stone size, with a diameter of less than 20 mm being the cut-off point. Shock wave monotherapy should not be used for larger stones and should be combined with other treatment modalities such as percutaneous nephrolithotomy or ureteroscopy. Other factors influencing outcome include stone number, composition and location, existence of congenital abnormalities, obesity and bleeding diathesis. Nomograms, artificial neural networks and computed tomography are useful adjuncts in predicting the outcome. Potential methods of improvement are the decrease of shock wave rate, the progressive increase in lithotripter output, the use of two simultaneous or sequential pulses and the use of expulsive and chemolytic treatment.*
***Conclusions:** Shock wave lithotripsy continues to be a significant part in the urologists armamentarium for the treatment of renal and upper ureteral stones.*

KEY WORDS: *Urinary calculi; Flexible ureteroscopy; Children.*

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INTRODUCTION

In 1982 the introduction of extracorporeal shock wave lithrotripsy (SWL) revolutionized the treatment of urinary calculi (1). Soon it was realized that not all stones are amenable to adequate fragmentation and spontaneous passage. Moreover, SWL's complication profile was proved to be minor but countable. As a consequence, after the initial major technological breakthrough, there have been numerous changes in the theoretical background and the technique of SWL, as well as technological advances in the Lithotripters that have attempted to improve its efficacy and decrease the interrelated morbidity. Parallel to SWL revolution, other minimally invasive techniques, such as percutaneous lithotripsy (PNL), retrograde intrarenal surgery and laparoscopy have emerged and also have been improved through the years. The latter techniques proved to be highly successful and of low morbidity, further decreasing the therapeutic spectrum of SWL. As a consequence, currently, urologists have to choose among various approaches to treat renal and upper ureteral calculi and should individualize therapy of every patient.

MATERIAL AND METHODS

English literature on the Medline and MeSH databases was reviewed. Key words used for search included shock wave lithotripsy, calculi, stones, renal, kidney, ureter, efficacy, prediction, improvement and guidelines. The aim was to review the functional results of SWL, to examine the factors which affect its success and to present current guidelines on SWL treatment of renal stones and proximal ureteral stones. Methods to predict which patients would benefit from SWL and methods to improve SWL efficacy were also reviewed.

Results

General Efficacy of SWL

Renal stones

Several studies have demonstrated the clinical efficacy of SWL in fragmenting and clearing calculi from the kidney, especially those less than 20 mm in diameter (2), and those in a location other than the lower pole (3-5). Success rates have exceeded 90% for stone clearance, with continued clearance of stone fragments up to 2 years after SWL (4). A decade ago the reported stone-free rates with the Dornier HM3 lithotripter were 75-89% for stones up to 20 mm compared to 39-63% for larger stones (6). Similarly, recent studies on newer lithotripters revealed stone-free rates of 66-99% and 45-60% for stones with diameter below and above 20 mm, respectively (7,8). A recent literature review showed that in a series of 35,100 patients treated for kidney stones with SWL, satisfactory disintegration was recorded in 32,255 cases (92%). The stone-free rate was 70% with re-treatments in 10.5%. When results reported during the last 7 years were considered separately, the stone-free rates between 41% and 90% corresponded very well to those reported for the Dornier HM3-lithotripter and for subsequently developed second- and third- generation lithotripters (9).

There is no consensus on the maximum number of shock waves that can be delivered at each SWL session. This number depends on the type of lithotripter and the shock-wave power being used. Taking into consideration that tissue damage increases with increased frequency of shock-wave delivery during treatment and that stone disintegration becomes better at lower frequencies, a frequency of 1-1.5Hz is recommended (9-11). Depending on the lithotripter used, the number of SWL sessions should not exceed three to five, otherwise an alternative method such as PNL should be offered. The interval between two treatments should be determined by the energy level used and the number of shock waves given. As the time required for resolution of contusions in the renal tissue is about 2 weeks, it is recommended that 10-14 days should pass between two successive SWL sessions for stones located in the kidney (12). The interval between two successive sessions must be longer for electrohydraulic and electromagnetic lithotripsy than for treatments with piezoelectric equipment. Shorter intervals between treatment sessions are usually acceptable for stones in the ureter (9, 12).

Proximal Ureteral stones

During the previous decade SWL was considered as the primary treatment choice for renal calculi < 20 mm and proximal ureteral calculi that do not pass spontaneously (13). However, recent retrospective and prospective studies demonstrated similar or superior efficacy of ureteroscopy compared to SWL for proximal ureteral stones (14-16). A retrospective review on 500 patients with proximal ureteral stones, which compared SWL in situ to Holmium:YAG laser ureterolithotripsy, showed comparable stone-free rates for calculi < 10 mm; 80% versus 100%, respectively. Ureteroscopy resulted in a 93% stone-free rate compared to 50% for SWL when the stone was > 10 mm (14). A low-powered prospective randomized trial comparing SWL to semi-rigid ureteroscopy for proximal ureteral stones > 15 mm, revealed higher stone-free rates and higher complication rates for ureteroscopy (15). Matched-paired comparison of the two treatment modalities showed similar efficacy for treating proximal stones, indicating that the choice of therapy depends more on availability of equipment and patient preference (16). A recent meta-analysis of high level of evidence, showed that overall, for stones in the proximal ureter, there was no difference in stone-free rates between SWL and ureteroscopy. SWL stone-free rate was 82% while additional procedures were infrequently necessary (0.62 procedures per patient). There was no significant difference between various SWL techniques (SWL with pushback, SWL with stent or catheter bypass, or SWL in situ). As expected, stone-free rates were lower and the number of procedures necessary were higher for ureteral stones > 10 mm in diameter managed with SWL. The current analysis also revealed a stone-free rate of 81% for ureteroscopic treatment of proximal ureteral stones, with surprisingly little difference in stone-free rates according to stone size (93% for stones < 10 mm and 87% for stones > 10 mm). The vast majority of patients rendered stone free in a single procedure. Superior stone-free rates were achieved using flexible ureteroscopy (87%) compared with rigid or semirigid ureteroscopy (77%), but this difference was not statistically significant. However, for proximal ureteral stones < 10 mm, SWL had a higher stone-free rate than ureteroscopy, and for stones > 10 mm, ureteroscopy had superior stone-free rates (17). Serious complications following SWL were infrequent. Complication rates for URS, most notably ureteral perforation rates, have been reduced to less than 5%, and long-term complications such as stricture formation occur with an incidence of 2% or less (17, 18). Significant advantages of SWL over ureteroscopy are that SWL is more easily and routinely performed with intravenous sedation or other minimal anaesthetic techniques, it is associated with fewer postoperative symptoms and has better patient acceptance than ureteroscopy. On the contrary, ureteroscopy can be applied when SWL might be contraindicated or ill-advised such as bleeding disorders, anticoagulants usage and morbid obesity (19, 20). Finally, ureteroscopy can be used safely to simultaneously treat bilateral ureteral stones in select cases (21).

Factors influencing SWL outcome

A variety of factors can affect the success rate of SWL. In addition to the efficacy of the lithotripter, these factors include the stone size, number, location and hardness, the habitus of the patient and the experience of the operator.

Stone burden

Stone size and number are important factors influencing the choice of treatment modality for renal and ureteral calculi. Although the problems associated with removal of stones from the kidney increases with the volume of the stone, there is no clear cut-off for a critical stone size.

Today, most authors consider a largest renal stone diameter of 20 mm as a practical upper limit for SWL, but larger stones are also successfully treated with SWL in some centres and other limits for SWL have been suggested (4,22). In general, SWL shows stone-free rates as low as 41-54% for large stones. In the treatment of stones with an area up to 40x30 mm the combination of PNL and SWL has emerged as a solution, with success rates of 71-96% and acceptable morbidity and complications (9, 23). Regarding staghorn stones, a recent meta-analysis showed that the overall stone-free rates for PNL, the combination of PNL and SWL and SWL as monotherapy were 78%, 66% and 54%, respectively. When PNL is the terminal procedure in the combined therapy and "*second look*" nephroscopy is performed, stone-free rates may rise to 81% (24). The only randomized, prospective trial comparing PNL to SWL for staghorn stone management demonstrated stone-free rates with PNL-based therapy to be more than three times greater than with SWL monotherapy (25). Combining primary procedures, secondary procedures to completely remove stones and adjunctive procedures to correct complications, PNL required 1.9, combination therapy 3.3 and SWL 3.6 total procedures, respectively. In the SWL group, stone-free rates and total procedures needed were higher for complete staghorn calculi compared to partial staghorn calculi. Although, transfusion need was lower for SWL the overall significant complication rate was similar for all treatment modalities, ranging between 13% and 19% (24).

Composition and hardness of the stone

Various investigators have demonstrated the relative susceptibilities of different stone compositions to SWL. When adjusted for stone size, cystine, brushite and calcium oxalate stones are more resistant to SWL compared to uric acid and calcium oxalate dehydrate stones (26, 27). Success rates for these two groups of stones were shown to be 60-63% and 38-81%, respectively (28). More specifically, stone-free rates of 71% for rough cystine stones with a diameter of less than 15 mm have been reported. When the diameter exceeds 20 mm the success rate for these stones drops to 40% (29).

Stone location

Stones < 20 mm in diameter, located in the renal pelvis are the most amenable to SWL, with stone-free rates of 56% to 80% (23). Similarly, for stones < 20 mm in the upper and middle calyces, SWL stone-free rates range from 57.4% to 76.5%, supporting this approach in most upper-tract stones of these characteristics (23). Lower pole stones treated with SWL are less likely to clear than stones in other regions of the collecting system. More than one decade ago, a metaanalysis of 2927 patients with lower pole stones treated with SWL or PNL showed stone-free rates of 53% and 90%, respectively. Further, it was determined that the stone-free rates for SWL decreased compared with PNL according to the stone burden, with a stone-free rate of 74 versus 100%, 68.2 versus 89%, and 32.6 versus 93.7% for stones < 10 mm, 11-20 mm, and > 20 mm for SWL and PNL, respectively (30). These results were recently reinforced by the outcome of two prospective randomized trials comparing different treatment modalities for lower pole stones. The first Lower Pole Study compared SWL with PNL for symptomatic lower pole only calculi < 30 mm. The overall stone-free rates were 37% and 95%, respectively. Stone-free rates for SWL and PNL in the 1-10, 11-20 and 21-30 mm groups were 63 versus 100%, 23 versus 93% and 14 versus 86%, respectively. No significant difference in complications rates was noted (31). A subsequent study from the same group compared SWL and ureteroscopy for the treatment of lower pole stones ≤ 10 mm. There was no statistically significant difference in stone-free rates between the two treatments (35 versus 50%) (32). Anatomy of the lower pole in the form of lower pole dependency, infundibulopelvic angle, infundibular width, length and diameter, lower infundibular length to diameter ratio and the number of calyces may affect stone clearance (33). However, it is not always predictive of stone clearance (34).

Collectively, the above data suggest that SWL constitutes a reasonable first-line treatment for lower pole stones < 10 mm in diameter, based mainly on acceptable stone-free rates, low morbidity and high patient preference (35). Finally, a recent comprehensive review showed that the success rates of SWL for stones located in diverticula are rather poor, since urine drainage is usually hindered. Therefore, an endoscopic, percutaneous, laparoscopic or a combined approach for treatment of both stone and stenotic infundibulum is recommended (36).

Congenitally abnormal and transplanted kidneys

Stone-free rates with SWL alone in anatomically anomalous kidneys range between 28 and 80%. Repeat SWL sessions are common for the majority of these patients. The major predisposing factor to success is stone burden. In general, stones < 10-15 mm in size can reasonably be managed with SWL or flexible ureteroscopy. PNL is preferred for larger stones (37).

Despite the risk of requiring multiple procedures, SWL can been performed safely in transplant patients with calculi < 15 mm. Although data are limited, high success rates of 100% have been reported. Patients are treated in the prone position and when there is a high probability for obstruction, placement of a stent or percutaneous nephrostomy tube is recommended (38,39).

Patient related factors

Despite initial fears of significant renal damage secondary to SWL in children, recent reports indicate that SWL is safe and effective for the paediatric stone population, attaining stone-free rates for renal and proximal ureteral stones in excess of 80% without significant sequelae to renal function or growth (40, 41). Similar to children, SWL is an option for old and fragile patients suffering from small renal stones. Advanced age is not a serious issue in PNL outcomes in terms of stone-free status and complications. As a consequence indications for this category of patients are similar to other adults (9). SWL in obese and morbidly obese patient has been considered from some authors as a contraindication because the low stone-free rates reported and because technically is difficult to match F2 with renal stone and the likelihood of producing unnecessary renal or surrounding organs tissue damage. In this patient population SWL is not recommended in the context of patients with BMI?30, stone size > 10 mm and stone density in CT scan > 900 HU (9). Finally, although SWL can be effectively and safely administered to patients on antithrombotic therapy when performed through a heparin window, it is absolutely contraindicated in patients with uncorrected bleeding diatheses. In case withdrawal of anticoagulation therapy is precluded flexible ureteroscopy is the preferred treatment option (9).

Predicting the outcome of SWL

Taking into consideration that several factors affect SWL outcome, it makes sense that a model or other factors capable of predicting SWL success rate in advance, could be of major importance.

Nomograms

Recently, a multivariate analysis and logistic regression analysis on patient age, sex and body mass index, number of stones in each treatment, stone size, side and location was published. Stone size, location and number were identified as significant variables on multivariate analysis and were included in a prediction nomogram. According to this nomogram the stone-free probability was highest for solitary proximal ureteral stones <5mm in size (93.8%) and lowest for multiple calyceal stones > 21 mm (10.5%) (42).

In another study, the success rate of SWL at 3 months for the treatment of renal stones < 30 mm could be predicted by stone size, location and number, radiological renal features and congenital renal anomalies. Other factors including age, sex, nationality, de novo or recurrent stone formation and ureteric stenting had no significant impact on the overall success rate (43).

Failure of SWL in the treatment of ureteral stones is significantly related to pelvic location, stone size > 10 mm, ureteral obstruction and obesity (BMI > 30). The strongest independent predictors of failure were pelvic stones and stones > 10 mm (44). In another study on the management of ureteral calculi, stone size was the only significant factor correlating with failure (45).

Artificial neural networks (ANN)

ANN has recently been created to predict the outcome of SWL. In a recent study of predicting optimum renal stone fragmentation after SWL, ANN identified stone size as the most influential variable, followed by total number of shocks given and 24-hour urinary volume. ANN accurately predicted optimal fragmentation in 77% of patients and identified all patients in whom fragmentation did not occur (46).

In another study an ANN, that incorporated both anatomic factors and dynamic measurements of urinary transport from intravenous urograms, was created to predict clearance of lower pole stones. ANN was shown to have a 92% predictive accuracy. Overall stone clearance was reported at 68% and the most influential prognostic variables were pathological urinary transport, infundibuloureteropelvic angle 2, body mass index and caliceal pelvic height which had a 15-fold relative weight over other inputs (47).

An artificial neural network can also help in accurate prediction of those who would be stone-free after SWL for ureteral stones. In a recent study, for a total stone-free rate of 93.3%, an ANN including demographic patient data and stone characteristics showed that stone length, location, stent use and stone width were the most influential input variables. Comparing logistic regression with ANN revealed a sensitivity of 100 and 77.9%, a specificity of 0 and 75%, a positive predictive value of 93.2 and 97.2% and an overall accuracy of 93.2 and 77.7%, respectively (48).

Computed Tomography (CT) findings

No consensus exists on the use of Hounsfield units (HU) and stone fragility, although evidence points to higher HU being SWL resistant (49, 50). The various characteristics of renal stones as determined by non-contrast CT scan have been related to SWL outcome. A recent multivariate analysis demonstrated that a stone burden of more than 700 mm^3, the presence of non-round/oval stones and a maximal stone density of more than 900 HU were statistically significant predictors of a failure outcome for SWL (51). Another study showed a worst SWL outcome in patients with calculus densities of > 750 HU and diameters of > 11 mm, with stone-free rates of only 60% and with re-treatment rates of 77% (52). Total stone volume, mean attenuation value and the heterogeneity of the attenuation value histogram successfully predicted SWL success rate in renal and proximal ureteral stones with an accuracy of 82.1%, 83.9% and 91.1%, respectively (53). In a recent retrospective study, logistic regression analysis showed that the skin-to-stone distance was the only significant predictor of stone-free status after SWL, compared to BMI and HU density. A distance more than 10 cm was associated with treatment failure (54).

Methods to improve SWL outcome

Shock wave rate

Shock wave rate is well known to affect stone fragmentation. Several prospective randomized studies showed that for renal or proximal ureteral stones slow-rate SWL (60-90 shocks/min) resulted in a better outcome than fast-rate SWL (120 shocks/min) (10, 55-59). Overall success rates of 75-98.7% have been reported for the slow-rate group compared to 61-90% for the fast-rate group (56,57). This benefit is more marked for larger stones. For a diameter between 10-20 mm stone-free rates of 32-46% and 67-71% have been reported for the fast-rate (120 shocks/min) and the slow-rate (60-80 shocks/min) groups, respectively (57, 58). When stones < 10 mm are being treated differences between the two groups become less significant. It is difficult to decide about the optimal shockwave frequency. A recent prospective randomized study compared 60, 90 and 120 shockwaves per minute frequencies and showed that the optimal frequency in terms of duration, efficacy and analgesic and sedative requirement at the same total energy level, was the 90 shocks per minute (58). Slower rates are associated with an increase in the procedure time but with a decrease in the total number of shock waves and lower power indices to fragment the stone, a decrease in re-treatment rates and a decrease in morbidity rate (10, 56-59).

Progressive increase in lithotripter output
Experimental studies have shown that a progressive increase in lithotripter output voltage during SWL can produce greater stone fragmentation than protocols employing a constant or decreasing output voltage (60). However, clinical studies are lacking and urgently required.

Twin-pulse technique and sequential twin-pulse delivery
Based on sufficient data on experimental studies, a prospective clinical study reported promising preliminary results using the twin-pulse technique, two identical shockwave generator reflector units mounted at an angle and activated simultaneously, to fragment stones. Fifty patients with a radio-opaque single stone in the kidney or upper ureter were treated with the twin-head lithotripter and all rendered stone-free within 1 month, with minimal morbidity (61). Similarly, the delivery of two shockwaves, at carefully timed close intervals was shown in experimental studies to improve stone fragmentation (62, 63). Clinical studies are required to confirm these results.

Percussion, diuresis and inversion (PDI) therapy
Manoeuvres to improve stone clearance after SWL for lower pole stones have been investigated. These have included combinations of manual percussion, diuresis and inversion, referred to as PDI therapy. Randomized controlled studies have shown better stone-free rates following PDI therapy (64, 65). However, patients are unlikely to elect for SWL and time-consuming PDI sessions if definitive treatment can be achieved in a single visit (66).

Patient position
Recent papers are suggesting that treatment of patients with ureteric stones in a prone or rotated position achieved a better SFR, increased tolerance of shock waves, and required a lower mean number of sessions (67, 68). However, in a recently published thorough review, authors felt that the literature on position for treatment of proximal ureteric stones is not conclusive, and further well-designed studies with greater number of patients are required (66).

Insertion of ureteral stents prior to SWL
Prospective randomized studies have underlined that stone-free rates in stented patients did not differ from those in non-stented patients. These studies also indicated that ureteral stents should not be used in patients with large renal calculi, since they did not reduce post SWL morbidity and they had side effects of their own (69-71).

Expulsive therapy and SWL
Recent literature suggests that a-blockers might increase stone clearance rates and reduce the symptom of ureteric colic and analgesic requirement following SWL. The effect is more remarkable in large stones which may continue to clear after 3 months if the drug is continued (72, 73). Still, the level of evidence on this topic is low and further studies are needed (66).

Chemolytic pre-treatment and after-treatment
In vivo studies suggest that changing the urine chemical environment prior to or at time of SWL we may be able to improve stone fragmentation (74). Pharmacologic therapy, such as potassium citrate and thiazide diuretics, has been successfully used to facilitate clearance of fragments post-SWL (75, 76). Although a prospective study has shown increased clearance of calcium oxalate lower pole calculi after SWL (75), larger studies incorporating different clinical scenarios are needed.

Discussion

Based on systematic review and metaanalysis of the published data, European Association of Urology (EAU) and American Urological Association (AUA) have published specific guidelines on urolithiasis. These guidelines clearly describe the current role of SWL in the treatment of renal and proximal ureteral stones.
According to the EAU guidelines SWL constitutes the first choice of treatment for radiopaque renal stones with a surface area ≤ 300mm^2 (≤ 20 mm). The recommendation is based on grade A and 1b level of evidence. With the same level of evidence percutaneous nephrolithotomy is recommended as the second line of treatment. Retrograde intrarenal surgery constitutes a third option based on grade C and 2a level of evidence data. For uric acid stones of same burden SWL lithotripsy is the second option following oral chemolysis and always in combination with the later (grade B, level of evidence 2a) (9).
Based on the results of their meta-analysis the AUA guidelines group for the treatment of staghorn calculi recommended PNL as the first treatment option for either complete or partial staghorn stones. PNL should be the last alternate in the combination therapy. Shock wave lithotripsy monotherapy should not be used for most patients, especially when cystine stones are being treated; however, if it is undertaken adequate drainage of the treated renal unit should be established before treatment. SWL monotherapy is an optional treatment in patients with stone burdens of < 500 mm^2 with normal collecting-system anatomy and in children (24).
The combined committee of AUA and EAU recommended that for patients with proximal ureteral stones requiring stone removal both SWL and URS should be discussed as initial treatment options for the majority of cases [Based on review of the data and Panel consensus/Level 1A-IV). Regardless of the availability of the equipment and physician experience, the patient should be discussed about stone-free rates, anesthesia requirements, need for additional procedures, and associated complications (standard option). Patients should be informed that URS is associated with a better chance of becoming stone free with a single procedure, but has higher complication rates. The meta-analysis demonstrated that URS yields significantly greater stone-free

rates for the majority of stone stratifications. The panel also recommended that routine stenting should not be performed as part of SWL and is optional following uncomplicated URS (17).

Conclusion

During the last 20 years SWL has revolutionized the management of stone disease and still has discrete indications. The limitations of renal and upper ureteral SWL have led to changes in SWL practicing, including changes in methods of patient selection regarding stone burden and anatomical location of stone. The existing technology in SWL has been modified to increase efficacy or reduced morbidity and new technologies are currently being developed that may change the way lithotripsy is performed in the future.

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PRESENTATION

Laparoscopic and open stone surgery.

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Summary

***Introduction:** Due to the increasing spread and technical enhancement of endourological methods, open surgery for renal and ureteral calculi almost disappeared.*
***Materials und Methods:** Based on an actual review of literature, we describe indications, technique and clinical importance of the open and laparoscopic management of urolithiasis.*
***Results:** In Europe and Northern America, the surgical therapy of urolithiasis only plays a role in cases of very large or hard stones, after failure of shock wave lithotripsy, percutaneous nephrolithotripsy or ureteroscopic stone removal and in cases of abnormal renal anatomy. However, in emerging markets with different structures and funding of the health care system and with a limited access to endourological procedures, these techniques still have a higher importance. Particularly in Europe laparoscopic surgery is emerging because calculi can be removed from almost all locations within kidney and ureter using a transperitoneal or retroperitoneal access. Functional outcomes and complication rates are comparable to open surgery. The benefits of laparoscopy are: less postoperative pain, shorter hospital stay, faster reconvalescence, and better cosmetic results.*
***Conclusions:** Although open and laparoscopic removal of renal and ureteral calculi is only performed in a limited number of cases in daily urological practice, they may be superior to the endourological techniques in some circumstances. Therefore, they should be considered as a part of the urological armamentarium.*

***KEY WORDS:** Urolithiasis; Ureterolithotomy,; Laparoscopy.*

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INTRODUCTION

Due to the major improvements in the fields of endourology (ureterorenoscopy and percutaneous nephrolithotripsy) and shock wave lithotripsy, the need for open surgery for ureteral and renal stones has diminished. Nevertheless, the Guidelines of the European Association of Urology (EAU) state that the methods of open stone surgery are still needed in some special situations1. Several centres reported that open surgery was used in 1% to 5.4% of all cases treated for urolithiasis (2-6). However, the EAU Guidelines point out that laparoscopy as a tool in the therapy of ureteral or renal stones is increasingly used in situations for which open surgery would previously have been used (1). This review focuses on the indications and possibilities of open and laparoscopic stone surgery and their place in daily clinical practice.

HISTORICAL BACKGROUND

"*Such calculi should be removed by pyelolithotomy*" *John Wickham* postulated in 1979 when addressing the treatment of a stone with a diameter of five millimetres in a renal calyx (7). More than 50 pages of his book were dedicated to the different surgical techniques. Some years later, the same author declared in an abstract: "*Open surgery for the removal of renal and ureteral calculi has been rendered almost obsolete in the last eight years*" (8). He talked about the years which had completely changed the therapy of urolithiasis. Today, there are few indications for open stone surgery. The knowledge about the technique of open lithotomy vanishes slowly (9). A long standing tradition seems to end: detailed descriptions of lithotomies for bladder stones by Susruta, a Hindu surgeon, are found in the sixth century BC. Ammonius (Egypt, second century B.C.) and Celsus (Rome, around the Nativity) depicted a perineal access to bladder stones. In mediaeval times, lithotomies were performed by barber-surgeons. Suprapubic accesses were also described in these times. Until the end of the 19th century, surgeons were mostly used to treat stones only in cases of obstruction or infection. The first report of an open lithotomy in a kidney which was not infected was published by *Morris* in 1880 (10).

Indications of open stone surgery

Open lithotomy is still an option when ureteral or renal stones cannot be managed by endourological procedures or shock wave lithotripsy (11):

– In cases of staghorn calculi, open surgery competes against percutaneous endourological approaches (PCNL), sometimes combined with shock wave lithotripsy. The stone-free rate after open surgery for staghorn calculi is 71% (56-84%) in a meta-analysis, the rate of significant complications is 13% (4-27%). The stone-free rate after PCNL is 78% (74-83%) with severe complications in 15% (7-27%) of the procedures (12).
– In some rare cases, the access to the stones is not possible with endourological instruments. Anatomical variations, cicatrisation, interposition of bowel or modified anatomical situations after surgical procedures (for example after transplantation of a kidney) can be responsible for the failure of endourological techniques. In some of these circumstances, shock wave lithotripsy also does not lead to the goal.
– Non-functioning kidney or non-functioning pole: Total or partial nephrectomy is a curative treatment option that avoids further stone formation.
– Stone formation in a calyceal diverticulum: Indications for treatment may be relapsing infections or haematuria. Shock wave lithotripsy is only capable when the orifice of the diverticulum is wide enough to let the stone fragments pass through. In cases with narrow orifices, the stones may also not be reached by endourological instruments. In these cases, open surgery can be a useful alternative (13).
– Co-incidence of stones and other renal or ureteral pathologies that require a surgical intervention, for example surgical stone removal during pyeloplasty.

Technique of open lithotomy

After exposure of the kidney, the removal of the stones can be performed in different ways:

– Pyelolithotomy with incision of the renal sinus (*Gil-Vernet*) (14).
– Anatrophic nephrotomy (*Boyce*) (15).
– Radial nephrotomy using intraoperative Doppler ultrasound to avoid the injury of major arterial branches (*Riedmiller*) (16).

Initially these operations were done using ischemia and hypothermia of the kidney. Technical advancements made it possible to do the procedures without clamping and cooling (17). Ultrasound and X-rays using needles for identification can help to locate the stones intraoperatively (18). In cases of stones in the proximal ureter, the ureter is usually exposed via flank section. The distal ureter can be reached through a pararectal incision. For stone removal the ureter is incised and afterwards sutured (17).

Indications for laparoscopic stone therapy

In current urological literature, laparoscopic removal of ureteral or renal calculi is, according to open stone surgery, described as a method for special cases in which stone therapy using endoscopic techniques or shock wave lithotripsy is insufficient.

Indications for laparoscopic pyelolithotomy are:

– Anatomical variations in location or shape of the kidney (pelvic kidney, horseshoe kidney, malrotated kidney) (19-27).
– Stones in diverticula of the renal pelvis which cannot be reached endoscopically and in which the passage of stone fragments after shock wave lithotripsy is not assured (28-30).
– Stones which are too hard or too large for endoscopic techniques or shock wave lithotripsy (Figure 2) (25, 31, 32).
– Stones in a renal pelvis that is constricted due to cicatrisation (25, 31, 32).
– Non-compliance or morbid adiposity of the patient (25, 31-33).
– Co-incidence of nephrolithiasis and other affections of the kidney which require a laparoscopic treatment of the kidney, for example total nephrectomy in a cirrhotic kidney with stones or laparoscopic pyeloplasty in ureteropelvic obstruction associated with stones (27, 32-35).

Indications for laparoscopic ureterolithotomy:

– Size of the stone > 15 mm (36-40).
– Durable impacted or very hard stones which are not capable for ureteroscopy or shock wave lithotripsy (38, 40-48).
– Social or economic necessity of stone removal in one single treatment session (40, 49).

Techniques of laparoscopic stone surgery

Transperitoneal access

a) *General laparoscopic access to kidney and ureter:* The patient is placed in lateral 45° decubitus position. A Verres needle is inserted laterally to the rectus abdominis muscle paraumbilically, the pneumoperitoneum is attained. The trocars are then inserted through the anterior abdominal wall. Following intra-abdominal inspection, either the ascending colon (right kidney) or descending colon (left kidney) is mobilized through a laterocolic incision of the peritoneum along the white line of Toldt. When the colon is free to fall medially, one or two additional ports can be inserted through the newly exposed retroperitoneum. After identification of the psoas muscle and the ureter, the ureter is followed cranially as the leading structure to the renal hilum.

b) *Transperitoneal pyelolithotomy:* After a longitudinal incision of the renal pelvis, the stone is mobilised. If there are difficulties in finding the stone, or if there are additional small calculi in the renal pelvis after removal of a

Figure 1.
The renal pelvis of a horse shoe kidney is open for laparoscopic removal of a stone.

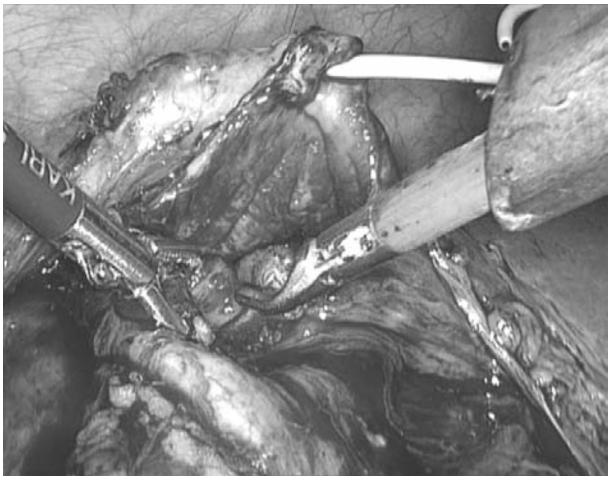


Figure 2.
After a longitudinal incision of the ureter the ureteral calculus is visible.

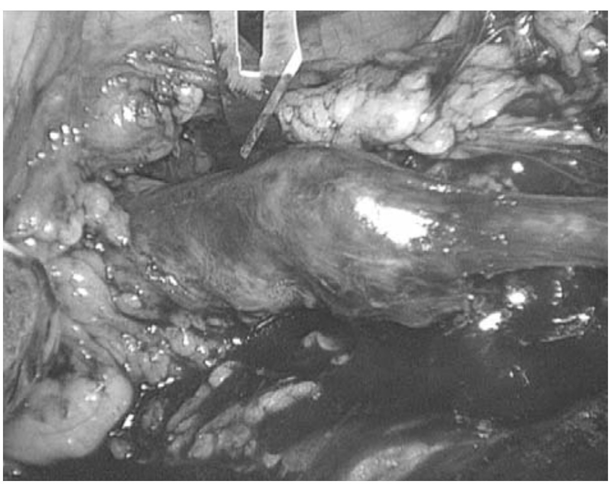
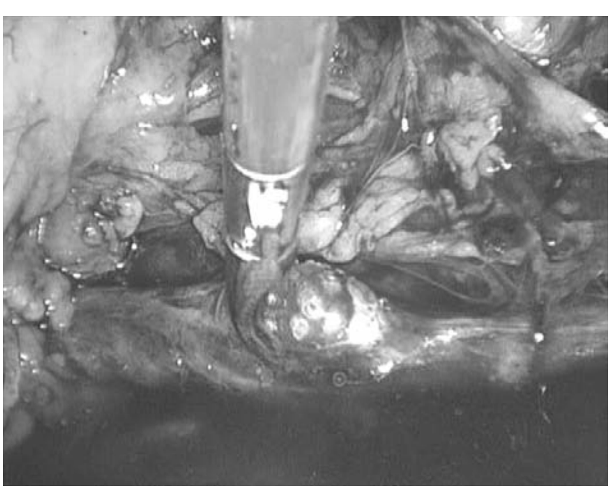


Figure 3.
A grasper is used to remove the stone from the ureter.



large stone, intracorporal ultrasound (50), a combination of laparoscopy and percutaneous nephroscopy (26) or the insertion of a flexible scope through one of the ports (25) can be helpful. An organ bag can help to bring out large or multiple stones. After stone removal, the renal pelvis is closed using a running intracorporal suture. If no Double-J stent was placed preoperatively, it should be inserted before suturing. We normally use an additional drain in the retroperitoneal space to prevent the formation of an urinoma.

c) *Transperitoneal removal of stones in a diverticulum of the renal pelvis:* In the majority of cases, there is only a thin layer of tissue to be inserted using electrocauterisation to free the stone (51). In some cases there is difficulty to localise the diverticulum because it does not bulge out over the contour of the kidney. Therefore, preoperative imaging is recommended in all cases. Sometimes, intracorporal untrasound can be useful, too (50). After removal of the stone and the diverticulum, the gap may be filled with fatty tissue or Gerota's fascia (28, 51). Synthetic glue can also be considered for closure (29).

d) *Transperitoneal pyelolithotomy in kidneys with anatomical abnormalities:* In cases of ectopic or malrotated kidneys or in kidneys with irregular form, modifications in the way of access and in the position of the trocars can be necessary. These procedures should only be done by experienced laparoscopists. Preoperatively, accurate imaging and planning are mandatory.
   - The prevalence of *horseshoe kidneys* is about 0.25%. Frequently the are associated with complications as obstruction, infection of stone formation (52, 53). Because both pelvises point ventrally they can be sufficiently reached using a transperitoneal access (54) (Figure 1).
   - The prevalence of *pelvic kidneys* is lower (0.02-0.03%). On the left side they are more frequent than on the right (55, 56). The laparoscopic access to a pelvic kidney is transperitoneal (23-27, 57). At the beginning, a transureteral balloon catheter is placed into the renal pelvis to make its laparoscopic identification easier. After filling the renal pelvis with contrast media, X-rays can be used for orientation (23, 24).

   In cases of pelvic kidneys as well as horseshoe kidneys, the technique of laparoscopic assisted percutaneous nephrolithotripsy is described. The percutaneous puncture of the renal pelvis with a needle is done under laparoscopic guidance to prevent injuries to other structures in difficult anatomical circumstances. Laparoscopic instruments can be used to guide the needle into its aim1 (9, 58, 59).

e) *Transperitoneal laparoscopic ureterolithotomy:* After opening the peritoneum, the ureter is exposed. Important anatomical landmarks are the psoas muscle and the gonadal veins. Large stones are clearly identifiable in most cases, for smaller stones imaging can be used as described for stones in the renal pelvis. After identification of the calculus, the ureter is temporarily occluded proximally and distally of the stone to prevent shifting. Most authors prefer a longitudinal incision of the ureter for stone removal (Figures 2 and 3). The closure of the ureter should be done using an intracorporal suture after inserting a Double-J stent (Figures 4 and 5). However, some authors state that a suture was not necessary when a stent was put in place. A drain should be inserted to prevent the formation of an urinoma irrespective of the closure technique (32, 38, 40, 49, 60).

Retroperitoneal access

The patient is placed in flank position. A 15 to 18 mm incision is made in the lumbar triangle (Petit´s triangle) between the twelfth rib and the iliac crest, bounded by the lateral edges of the latissimus dorsi and external oblique muscles. After creating a tunnel to the retroperitoneal space using overhold forceps for blunt dissection, the tunnel is dilated until an index finger can be inserted. The peritoneum is pushed forward by the index finger, a retroperitoneal cavity is created. Now the cavity is widened using a balloon-trocar system. Under palpation with the index finger, which is introduced through the primary access, two secondary trocars (10 mm and 5 mm) are inserted. The primary incision is closed around a camera port to prevent gas leakage. The pneumoretroperitoneum is established using a maximum carbon dioxide pressure of 12 mm Hg and a flow of 3.5 l/min. A forth trocar can be inserted if needed. Independent of the retroperitoneoscopic procedure performed, Gerota's fascia is incised completely. The psoas muscle is exposed as the most important anatomical landmark. Now, all further anatomical structures such as ureter, spermatic/ovarian vein and the lower pole of the kidney can be exposed. The incision of the renal pelvis or of the ureter for stone removal is done in a similar way as described for the transperitoneal access.

Figure 4.
Insertation of a Double-J-stent.

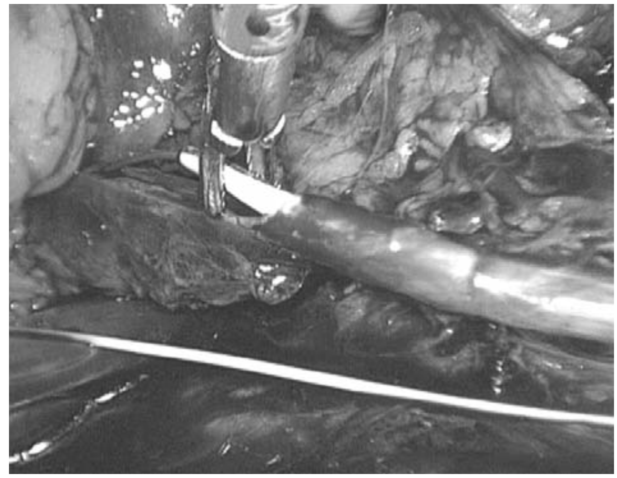
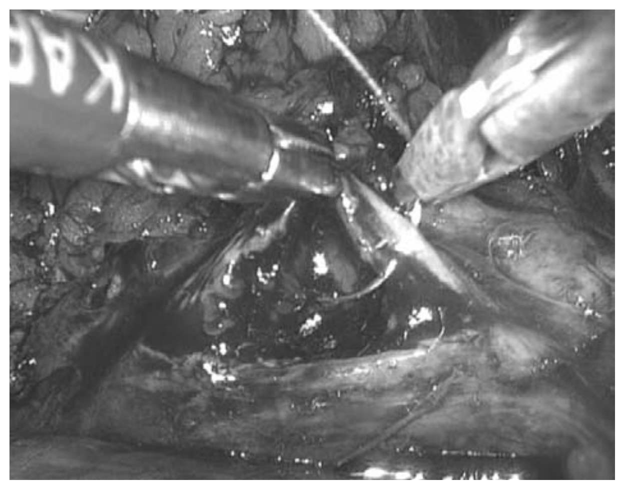


Figure 5.
Intracorporal suturing of the ureter after stone removal.



Discussion

Technique of open and laparoscopic stone surgery

The size and the location of a ureteral stone play an important role in the decision between endourological treatment, shock wave therapy, open surgical therapy and laparoscopic stone removal. As described in an article by *Park et al.*, there is a relevant difference in the success rates of ureteroscopic treatment of distal and proximal ureteral stones (94.6% *versus* 75.0%). Freedom from stones is achieved after one session of shock wave lithotripsy in 84% of all cases with a stone size up to 10 mm, but only in 42% of the cases with larger stones (61). *Pace et al.* reported similar results of shock wave lithotripsy depending on stone size (74% in patients with stones < 10 mm versus 43% in individuals with stones > 10 mm) (62). *Keeley et al.* however, stated that indications for open and laparoscopic stone surgery will furthermore be minimized due to technical improvements in endourology (for example due to the introduction of Holmium laser in ureteroscopy) (37).

This prediction will surely come true in Europe and Northern America. In contrast, there is a completely different situation in developing countries. In those countries, a high incidence of huge renal and ureteral stones is found, combined with very poor financial resources and problems in medical infrastructure and availability of modern endourological instruments. In this environment open stone surgery provides several advantages: The instruments needed are simple, wide-spread, inexpensive and low-maintenance. The wages of medical personal and the costs of operating facilities are low. In open surgery, the consumption of resources is significantly lower than in endourological procedures. Freedom from stones is usually reached within one single hospital stay. This results with low costs for the patients who usually do not have an adequate health insurance. Repeated hospital stays for the treatment of the same stone are avoided. Interestingly, *Kijvikai* and *Patcharatrakul* from Thailand reported that more and more surgeons in their country use the benefits of laparoscopy: Laparoscopy combines the main advantages of open stone surgery, the high stone-free rate within one treatment session, with the benefits of minimally-invasive treatment (shorter hospital stay and convalescence, less consumption of analgesics) (49).

Concerning the technique of laparoscopic stone surgery can be stated that a larger working space and a more familiar overview of the anatomical landmarks are the main benefits of the transperitoneal access. A higher rate of complications related to the bowel and complications due to urine extravasation into the peritoneal space are the most common disadvantages of this access. The retroperitoneal access should be preferred for operations on the pyelon of the orthotopic kidney and on the proximal ureter. Previous retroperitoneal surgery however precludes a second operation via retroperitoneal access because of adhesions limitating the possibility of developing the retroperitoneal working space (63, 64).

Reviewing the current literature, there is no agreement if the incision of the ureter to remove the calculus should be made by using a diathermal hook or a cold laparoscopic knife. *Nouira et al.* reported a higher stricture rate after using diathermia (60). *Harewood et al.* however used diathermia in all their patients. The stricture rate in this study was 0% (65).

The question if the incision of the ureter should be sutured after stone removal and if a Double-J stent should be used is also debate. In 1994, *Demerici et al.* propagated suturing the ureter without stenting, however their series was small (48). *Kijvikai et al.* presented the data of 30 patients in 2006: they sutured the ureter using single stitches without inserting a stent. A drain was used to prevent the formation of urinomas. Only one of their patients underwent Double-J stenting after prolonged loss of urine via the drain (49). *Hemal et al.* reported in a similar series that Double-J stenting for persisting extravasation of urine was necessary in two of their 31 patients (47).

The stricture rate after laparoscopic ureterolithotomy is about three percent (66). *Keeley et al.* and *Nouira et al.* however presented a higher stricture rate due to a too tight suture of the ureter. *Keeley et al.* concluded that a suture of the ureter should not be recommended at all after inserting a ureteral stent and a drain in the retroperitoneal space (37). *Nouira et al.* however favor an adapting, non-watertight suture of the ureter after insertion of the Double-J stent (60).

Interestingly, the theory of *Mitchson* and *Bird* on the development of ureteral stenosis after laparoscopic ureterolithotomy is contrary: they blame a retroperitoneal fibrosis due to an extravasation of urine into the retroperitoneal space and therefore postulate the need of a watertight suture of the ureter (67).

Gaur et al. stated that in cases of a chronically infected or oedematous ureter the probability of an insufficiency of the suture leading to an extravasation of urine is elevated. Therefore, they suggest only to stent the ureter without any suture in these special cases (40).

Especially in the United States the number of robotic-assisted laparoscopic procedures is increasing. In some cases, the laparoscopic pyelolithotomy was also performed using this technique (68, 69). However, especially in these rare procedures, the value of robotic-assisted surgery in daily clinical practice can not be rated at the moment.

Results of laparoscopic and open stone surgery

In 2000, *Rassweiler et al.* presented a comparison of open surgical versus endourological stone treatment (Table 1) (70): It was concluded that the rate of stone-free patients after 36 and 42 months showed no significant difference (72% *vs* 60%) although it had been significantly higher in the open group at the time of discharge from the hospital (80% *vs* 31%). Asymptomatic remnants were significantly more frequent in the endourological group (25% *vs* 3%). However, there was no difference in the rate of symptomatic remnants. The recurrence rate was significantly higher in the open group (20% *vs* 7%). There was a significant reduction of urinary tract infections after endourological therapy.

Few data have been published on the topic of laparoscopic pyelolithotomy and ureterolithotomy. Even major laparoscopic centers are not able to present high numbers of patients who underwent these infrequent procedures. Beside a number of case reports on this subject there are only few studies with sufficient collectives of patients. One publication reporting the data of 101 patients after laparoscopic pyelolithotomy can be found (40). Only two further reports including more than 30 patients have been published (45, 49). There are no randomised studies comparing the open and laparoscopic approach. Only two non-randomised comparative studies can be found, they are summarized in Table 2. *Skrepetis et al.* compared the results of 18 patients after laparoscopic stone surgery to a former series of 18 patients after open surgery: In the laparoscopic group, less analgesic medication was required, hospital stay and time to convalescence were shorter. However, operative times were significantly longer. There were no significant differences in stone free rates and complication rates (71). Goel and Hemal compared 55 patients after laparoscopic treatment to 26 after open surgery. Their results were similar to those of Skrepetis and his group. Additionally they stated that there was

Table 1.
Comparison between open and endourological stone therapy (70).

	Open surgery (n = 61)	**Endourological therapy** (n = 186)	
Stone-free at discharge	49 (8%)	58 (31%)	p > 0.05
Mean follow-up	42 months	36 months	
Stone-free	44 (72%)	112 (60%)	n.s.
Asymptomatic remnants	2 (3%)	46 (25%)	p > 0.05
Symptomatic remnants	3 (5%)	15 (8%)	n.s.
Recurrence	12 (20%)	13 (7%)	p > 0.05
UTI at hospitalisation	35 (57%)	65 (35%)	
UTI in follow-up	18 (30%)	21 (11%)	
UTI after/before	0.51	0.32	p > 0.05

UTI = Urinary tract infection.

Table 2.
Comparison between laparoscopic and open ureterolithotomy (45, 71).

	Goel and Hemal 2001		Skrepetis et al. 2001	
	lap. retroperit.	*open*	*lap. transperit.*	*open*
Number of patients	55	26	18	18
Size of stones (mm)	21 (7-33)	24 (7-34)	19 (12-31)	17 (10-26)
Duration of procedure (minutes)	108.8 (40-275)	98.8 (60-125)	130 (110-190)	85 (60-110)
Postoperative hospital stay (days)	3.3 (2-14)	4.8 (3-8)	3.2 (2-5)	7.8 (7-11)
Time to convalescence (days)	12.6 (7-21)	21.7 (14-28)	12 (8-26)	22 (16-34)
Analgesics (mg Pethidin)	41,1 (25-75)	96,9 (50-150)	n.a.	n.a.
Duration of analgesic (days)	n.a.	n.a.	1 (0-2)	4 (2-7)

a steep learning curve in laparoscopic surgery for unexperienced surgeons leading to an initially high conversion rate (45).

Conclusions

Today most cases of stones in ureter or renal pelvis can be managed using endourological techniques (transureteral or percutaneous lithotripsy or shock wave lithotripsy). However, in some cases, the location, size or hardness of the calculi as well as an aberrant anatomy of the kidney may require open or laparoscopic stone surgery. The modern laparoscopic procedures are able to solve nearly all problems which were domains of open stone surgery formerly. A retroperitoneal as well as a transperitoneal laparoscopic approach may be useful depending on the location of the stone. Therefore, laparoscopic centers should provide both techniques. Compared to open surgery, the advantages of laparoscopy are less pain, shorter convalescence and better cosmetic results associated with a similar good functional outcome.

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