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Original Article

Cell Phone Electromagnetic Waves Exposure Impact on the Histopathologic Changes of Urinary System Stones in Rats

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HIGHLIGHTS

- Cell phone electromagnetic waves have a remarkable disintegrating effect on urolithiasis and the rate of detected stones.
- Cell phone electromagnetic waves have destructive pathological outcomes result from urinary tract calculi were notably diminished.
- Change in serology and histopathology of kidney decreased in CPEW+ Ethylene glycol compare to Ethylene glycol alone.

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ABSTRACT

Introduction
To assess the therapeutic efficacy of potassium citrate in the nonsurgical management of renal stones, we run this research. The prophylactic effects of Potassium Citrate over renal stone formation have been established but there is still a gap for its therapeutic effect.

Methods
Forty Wistar rats weighting 200±10g were enrolled and sub-grouped into four groups:1- Control, 2- Cases with Ethylene glycol to form the kidney stones, 3- Cases with Ethylene glycol and RF-EMW exposure, 4- Cases with RF-EMW exposure (10 in each group 5 male and five female). The study was run over one month and at the end of the study, the serological, histopathological, and radiological tests were done to evaluate the number and size of kidney stones.

Results
Forty Wistar rats weighting 200±10g were enrolled and sub-grouped into four groups:1- Control, 2- Cases with Ethylene glycol to form the kidney stones, 3- Cases with Ethylene glycol and RF-EMW exposure, 4- Cases with RF-EMW exposure (10 in each group 5 male and five female). The study was run over one month and at the end of the study, the serological, histopathological, and radiological tests were done to evaluate the number and size of kidney stones.

Conclusions
With the short-term exposure of rats to waves emitted from mobile waves, we conclude that cell phone electromagnetic waves had a remarkable disintegrating effect on urolithiasis and the rate of detected stones and destructive pathological outcomes result from urinary tract calculi were notably diminished.

Keywords: Cell Phone Electromagnetic Waves; Urolithiasis; Stone Formation; Histopathology

Introduction

Urinary tract stones or Urolithiasis such as kidney stones are small, dense, and solid particles in which are constituted in one or both kidneys and occasionally are conveyed to the ureters. Urinary stones may warry from a sand grain to a small ball in terms of their size and could be solitary or multiple. Urolithiasis generally involves adults older than 20 in both genders; however,

it is more common in males. Calculi evacuation causes severe and torturous pain in a few minute intervals. The pain initially emerges in the posterior lower border of the ribs; subsequently, bypassing the stone through the ureter, the pain immigrates to the inguinal area. Once the stone is eliminated, the pain stops; although, a non-evacuating and stable calculus presents no symptoms (1, 2). Different conditions are considered as the main triggers of Urolithiasis including dehydration, salt overuse, hyperparathyroidism, gout, urinary obstruction, chronic kidney infection, and irregular voiding habits (3-5).

There are various types of factors predisposing the urinary system to develop stones; the risk factors could be divided into two major groups of modifiable and non-modifiable. Certain biochemical abnormalities of the urine composition have been associated with an elevated risk for urolithiasis. These include higher urine calcium, lower urine citrate, higher urine oxalate, higher urine uric acid, and lower urine volume (6-8). Dietary factors can play a pivotal role in promoting stone formation, initially by affecting the urine composition. Diminished intake of fluid, calcium, potassium, and phytate and a greater intake of oxalate, sodium, sucrose, vitamin C, and possibly a proportion of proteins have collaborated with an increased risk for kidney stone formation (9-13). Numerous drugs consumption has been related to an enhanced risk of kidney stone formation. Some drugs like topiramate, acetazolamide, and long-term glucocorticoids can promote kidney stone formation by inducing metabolic abnormalities that alter the urine composition (14, 15). Since the metabolites of ethylene glycol can induce hyperoxaluria and calcium oxalate stones (16), for the development of a model of calcium-based renal calculi, ethylene glycol is the most commonly utilized agent in the experiments (17).

Based on the growing statistics of Urolithiasis, unceasingly various etiologies are investigated which the cell phone waves could be mentioned among these. Electromagnetic Radiation (ER) refers to the waves of the electromagnetic spectrum, propagating through space, carrying electromagnetic radiant energy. It is classified by a frequency that includes radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and gamma rays (18). These waves have a variety of applications in the life-related daily routine utilized devices and systems including refrigerators, televisions, radios, copy machines, computer screeners, halogen lamps, and printers (19).

Increasing use of cell phones and numerous reports in recent years about abnormality developing effects of these waves on different processes of growth gave rise to concerns in terms of their harmful effects on human health. Currently, a great deal of evidence was revealed some of these critical non-thermal consequences such as cell function alteration, decrease in melatonin production, changes in electroencephalogram results, and gene expression patterns (20-26).

To the best of our knowledge, no study was implemented to investigate the influence of cell phone radiations on urolithiasis and the parameters related to the size, type, and location of the stones. Therefore, the present study was conducted on a rat model to address the aforementioned issue. We hope our findings open a novel path to the further understanding and treatment of urinary tract calculi.

Methods

Animals and Ethical Approval

Forty, 4 to 6-week-old, Wistar rats weighing 200±10 g were purchased and all of them are healthy. All rats were housed and caged in the animal facility at the Urology Research Center of Sina Hospital under an approved Tehran University of Medical Sciences ethics committee protocol (IR.TUMS.VCR.REC.1398.680). Regarding the environmental conditions, the average temperature and humidity were 24±1ºC and 50-55 percent, respectively; with a 12-h light-dark cycle. A mixture of 43 percent of vegetable proteins and grains consisted of the animal's chow.

Ethylene glycol with a purity of ≥99.5% was obtained from Sigma-Aldrich incorporation (Darmstadt, Germany). To generate cellphone waves, we used a wave transmitter with a wavelength equal to existing cellphones

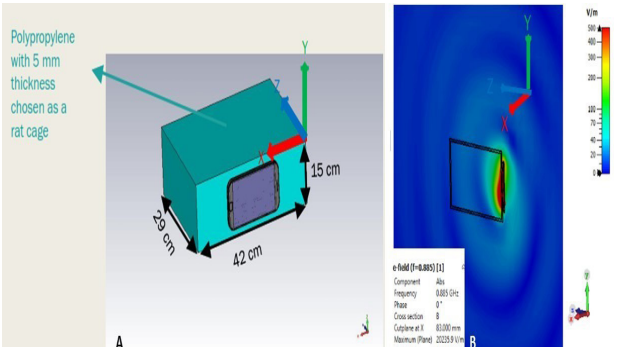

Figure 1. A: Phone on the side of the rat cage. B: Electric field at 885 MHz-phone on the side.

Figure 2. The rats positioning on the LOTUS-in Vivo Micro-CT table

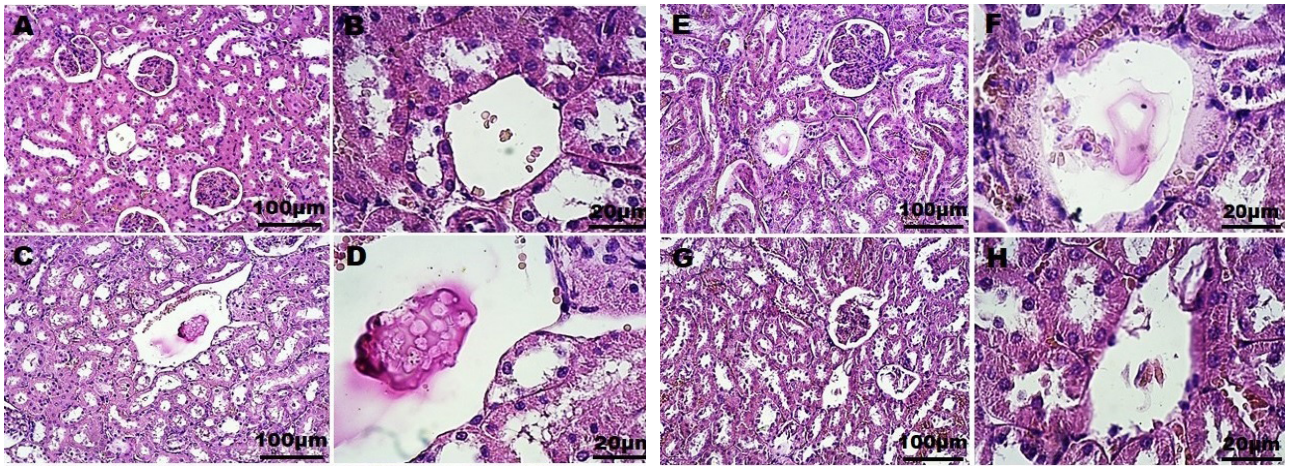

Figure 3. The histopathologic examination of the kidney. (A, B) Control group; (C, D) ethylene group; (E, F) mobile waves; (G, H) ethylene glycol + mobile waves.

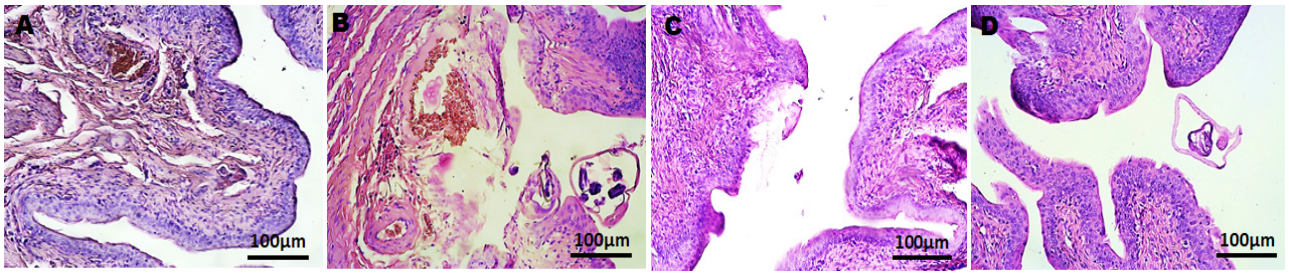

Figure 4. The histopathologic examination of the bladder. (A) Control group; (B) ethylene group; (C) mobile waves; (D) ethylene glycol + mobile waves

in the usual markets. At the time of wave transmission, the cages were entered in an aluminum box with just one open side to prevent the egression of waves (Figure 1).

This study evaluated the possible toxicological effects of exposure to 885 MHz Global System for Mobile Communications (GSM) like radiofrequency radiation (RFR) on the histology and ultrastructure of various body tissues of Wistar rats. Rats were exposed to FRF 12 times a day, each time 10 minutes for a month at a whole-body specific absorption rate (SAR) of 0.90 Watt/kg. 0.5

Animal Grouping and the Modeling Method

After a one-week acclimatization period, the rats were randomly allocated into 4 groups using a computer-generated randomization list: Group A served as the control group in which rats experienced no exposure; Group B was ethylene glycol receivers in which a daily amount of 3cc ethylene glycol was added to their diurnal 500cc drinking water; Group C acted as the wave exposure group in which rats underwent electromagnetic waves radiation for 12 times a day, 10 minutes each; finally Group D represented the associated exposure of waves and ethylene glycol as the above-mentioned routes. Before any intervention, 1 male and 1 female rat were randomly selected from each group to perform a CT-Scan to ensure there was no evidence of stones. Each group was contained 5 male and 5 female rats. The rats of each group were stained and numbered with the yellow color of Picric acid in different parts of their bodies (head, foot, right hand, and the waist for the group's A, B, C, and D, respectively). The period dedicated for all groups of animals' experimentations was 1 month.

Serum Analysis

Blood samples were collected from each rat, and the serum urea, uric acid, creatinine, calcium, phosphorus, and total protein levels were measured and compared to each other. 0.5

Radiologic Analysis

After the 4 weeks, 4 animals (2 males, 2 females) were randomly selected from each group and were anesthetized by 2% Xylazine and 5% ketamine. Afterward, the rats were placed in the supine position on the LOTUS-in Vivo Micro-CT (Advanced Medical Technologies & Equipment Institute, Tehran University of medical sciences, Tehran, Iran) table (as shown in Figure 2). Different radiographic images were captured in coronal and transverse planes. 0.5

Pathological Examinations

For further pathologic examinations of the urinary system,

Table 1. Serum parameters value in wave ethylene and control groups of

Serological Parameters	Waves Ethylene Group		Control Group		P-value*	P-value**
	Female	Male	Female	Male		
Urea	71±3.8	70±3.6	64.5±2.3	67.5±3.2	<0.001	<0.001
Uric Acid	93.5±3.3	95±4	31.09±1.3	23.15±1	<0.001	<0.001
Creatinine	8±0.9	6.5±0.3	31.23±1.4	56.09±2.9	<0.001	<0.001
Total Protein	7.5±0.5	8.4±1	8±0.9	7.02±0.5	0.876	0.946
Calcium	36±1.6	37±1.7	10.5±1	10.7±1.1	0.884	0.665
Phosphoric	19±1.6	19.5±1.7	14.2±2.3	10.6±1.1	0.001	<0.001

* Female in Waves Ethylene group vs. Control group ** Male in Waves Ethylene group vs. Control group

2 rats, including a male and a female, were randomly selected from each group and were sacrificed. Their urinary system including kidneys, ureters, bladder, and urethra was sent to the pathology center of Sina hospital of Tehran University of Medical Sciences for H&E staining, histopathologic examinations, and further outcomes of the experiment. Other organs of those rats were applied in other ongoing studies in the same facility.

Results

Serum Parameters

In serum specimens of waves + ethylene glycol group, there was a significant difference in urea, uric acid, and creatinine compared to the control group in both genders; besides, a meaningful increment was seen in the level of phosphorus of female rats. The serum level of urea in the same group experienced a notable rise, regardless of gender, in comparison to rats of the ethylene glycol group. However, in the same comparative setting, just male rats met the level of significance for uric acid and creatinine levels. The results are detailed in Tables 1 and 2.

Radiologic Outcomes

The CT scan results have confirmed the formation of stones in the receivers of the ethylene glycol; while, there was no evidence of calculi in the control group. At the end of the trial, by evaluating the results of the radiologic examinations in the rats of simultaneous treatment with ethylene glycol and mobile waves, the size of stones was either undetectable or extremely small; however, the findings of radiologic examinations were unreliable and not led to a definite and meaningful conclusion.

Pathologic outcomes

The findings of the pathologic examinations were presented in Figures 3 and 4. Evaluation of slides provided from the kidneys of ethylene glycol group compared to normal tissue demonstrated hemorrhage in Bowman's capsule and glomeruli size decrement. Although the aforementioned changes were present in the mice of simultaneous exposure of waves and ethylene glycol, the extent of them was much less in this group. Lymphocytic cell ratio increased in comparison to other groups; additionally, epithelial cell death of Bowman's capsule wall was seen. In the central section of the tissues, the number of cells in the proximal and distal convoluted tubules were indeterminate, indicating the cell structure alterations. Also, the examinations revealed that there were calculi in the ethylene glycol group, independent of gender, which was greater in magnitude on the left side and had higher levels of inflammation.

Results of the Group C and D histopathologic investigations exhibited that the size and number of stones in these groups were diminished; however, the calculi still were seen in these groups and not removed. Other structural impairments including Bowman's capsule wall cell death and interstitial lymphocytes infiltration were slighter in these groups. The presence of cell membranes in distal convoluted tubules was more evident than proximal convoluted tubules. The epithelial membrane of collecting ducts in the renal medulla was subjected to no changes and remained intact.

Discussion

The primitive attempts regarding the noninvasive elimination of kidney stones were performed in Munich in 1972 (27). Following the numerous in-vitro investigations and animal trials, in 1980 a complete revolution has emerged and the widely known procedure, ESWL, was clinically introduced to disintegrate the urinary tract stones (28-30). This technique thereupon gained worldwide attention and was widely used in the management of patients suffering from urinary tract stones (31). Despite the wide range of yielded benefits, a minor, but slightly serious, series of disadvantages including damage to proximal structures, bleeding, inflammation, perforation, cardiac arrhythmias exist. Also, it is contraindicated in

Table 2. Serum parameters value in wave + ethylene glycol and ethylene glycol groups of the study

Serological Parameters	Waves Ethylene Group	Ethylene Group		P-value*	P-value**
	Female	Female	Male		
Urea	71±3.8	60±1.5	67±3	<0.001	0.001
Uric Acid	93.5±3.3	86±4	93.03±4.6	0.048	0.032
Creatinine	8±0.9	7±0.5	5.36±0.4	0.061	<0.001
Total Protein	7.5±0.5	7.05±0.6	7.01±0.5	0.233	0.911
Calcium	36±1.6	34±1.4	36.18±1.7	0.068	0.057
Phosphoric	19±1.6	17±2.4	18.9±2.9	0.159	0.291

* Female in Waves Ethylene group vs. Ethylene group ** Male in Waves Ethylene group vs. Control group

pregnancy and coagulopathies (32-34).

Over the recent years, along with the drastic progress in the territory of the telecommunication, application of cell phones has become a necessity. This improvement had plenty of advantages for the users; however, the other side of the new era still stays in the shadow. A wide array of studies has been implemented to identify the impact of electromagnetic waves on the different organs; nevertheless, it remains inconclusive (23). On the other hand, to find out whether the favorable effects of mobile waves on the body exist, we compared the rate of ethylene glycol-induced urolithiasis in the rats exposed to these waves and non-exposed ones.

In this study, we examined the effects of mobile waves on the urinary system stones induced by ethylene glycol in Wistar rats. The presence of urolithiasis in the rats who received ethylene glycol has been proved by CT Scan, multiple calculi have been formed in this group. In one of the experimental groups of our study, besides the treatment with the stone-forming agent, the rats experienced contact with the electromagnetic waves emitted from the cell phones, the mankind regularly is in touch. Surprisingly a considerable amount of calculi was disappeared, demonstrating the effectiveness of commonly used handheld devices in one of the most pain-causing conditions of the urinary system.

To extend our knowledge, this is the first report of mobile waves utilization in pulverizing urinary tract stones. Recognition of this study's limitations will be helpful in the future investigation's design and implementations; those include lack of determination of the stones size and the minimum dimensions of the stones of which these waves can fragment inability to employ human subjects instead of animals and the small sample size.

Conclusions

From the findings of our study regarding the short-term exposure of rats to waves emitted from mobile waves, we conclude that cell phone electromagnetic waves had a remarkable disintegrating effect on urolithiasis and the rate of detected stones and destructive pathological outcomes result from urinary tract calculi were notably diminished. Despite the beneficial impact of these waves in this study, to confirm the aforementioned results further investigations are needed.

Authors' contributions

VAY was the principal investigator, AN wrote the manuscript, RM and NN run the project and laboratory testing, LZ analyses the data, and DT edited the manuscript.

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Conflict of interest

All authors declare that there is not any kind of conflict of interest.

Funding

There was no founding.

Ethics statement

The study was approved by Tehran University of Medical Sciences ethics' committee protocol (IR.TUMS.VCR.REC.1398.680).

Data availability

Data will be provided on request.

Abbreviations

CT	Computed tomography
ER	Electromagnetic radiation
ESWL	Extracorporeal shock wave lithotripsy
RF-EMW	Radiofrequency electromagnetic wave of cell phones

References

1. Moe OW. Kidney stones: pathophysiology and medical management. The lancet. 2006;367(9507):333-44.
2. Worcester EM, Coe FL. Calcium kidney stones. New England Journal of Medicine. 2010;363(10):954-63.
3. Jungers P, Joly D, Barbey F, Choukroun G, Daudon M. ESRD caused by nephrolithiasis: prevalence, mechanisms, and prevention. American journal of kidney diseases. 2004;44(5):799-805.
4. Robertson W, Peacock M. The cause of idiopathic calcium stone disease: hypercalciuria or hyperoxaluria? Nephron. 1980;26(3):105-10.
5. Taşdemir M, Fuçucuoğlu D, Özman O, Sever L, Önal B, Bilge I. Silicate calculi, a rare cause of kidney stones in children. Pediatric Nephrology. 2017;32(2):371-4.
6. Curhan G, Taylor E. 24-h uric acid excretion and the risk of kidney stones. Kidney international. 2008;73(4):489-96.
7. Parks JH, Coe FL. A urinary calcium–citrate index for the evaluation of nephrolithiasis. Kidney international. 1986;30(1):85-90.
8. RUDMAN D, KUNTER MH, REDD SC, WATERS IV WC, GERRON GG, BLEIER J. Hypocitraturia in calcium nephrolithiasis. The Journal of Clinical Endocrinology & Metabolism. 1982;55(6):1052-7.
9. Curhan GC, Willett WC, Knight EL, Stampfer MJ. Dietary factors and the risk of incident kidney stones in younger women: Nurses' Health Study II. Archives of internal medicine. 2004;164(8):885-91.
10. Lemann Jr J. Composition of the diet and calcium kidney stones. Mass Medical Soc; 1993.
11. Mitchell T, Kumar P, Reddy T, Wood KD, Knight J, Assimos DG, et al. Dietary oxalate and kidney stone formation. American Journal of Physiology-Renal Physiology. 2019;316(3):F409-F13.
12. Ferraro PM, Mandel EI, Curhan GC, Gambaro G, Taylor EN. Dietary protein and potassium, diet–dependent net acid load, and risk of incident kidney stones. Clinical Journal of the American Society of Nephrology. 2016;11(10):1834-44.
13. Urivetzky M, Kessaris D, Smith AD. Ascorbic acid overdosing: a risk factor for calcium oxalate nephrolithiasis. The Journal of urology. 1992;147(5):1215-8.
14. Daudon M, Jungers P. Drug-induced renal calculi. Drugs. 2004;64(3):245-75.
15. Mehrsai A, Hashemian Naeini E, Dadkhah Tehrani F, Noori Jalayani K. Impact of Bone Mineral Density on the Recurrent Urolithiasis. Translational Research Urology. 2019;1(1):12-6.
16. Halabe A, Shor R, Wong N, Sutton R. Effect of vitamin D3 on the conversion of ethylene glycol to glycolate and oxalate in ethylene glycol-fed rats. Clinica chimica acta. 2003;330(1-2):135-9.
17. Li Y, McMartin KE. Strain differences in urinary factors that promote calcium oxalate crystal formation in the kidneys of ethylene glycol-treated rats. American Journal of Physiology-Renal Physiology. 2009;296(5):F1080-F7.
18. Serway RA, Jewett JW. Physics for Scientists and Engineers . Brooks/Cole. 2004.
19. Dimitris J, Pangopoulos H, Margarits P. Effects of electromagnetic field the reproductive capcity of melanogaster. Springer: Biological Effects of Electromagnetic Radiation; 2008.
20. Nakamura H, Matsuzaki I, Hatta K, Nobukuni Y, Kambayashi Y, Ogino K. Nonthermal effects of mobile-phone frequency microwaves on uteroplacental functions in pregnant rats. Reproductive Toxicology. 2003;17(3):321-6.
21. Ghatei N, Nabavi AS, Toosi MHB, Azimian H, Homayoun M, Targhi RG, et al. Evaluation of bax, bcl-2, p21 and p53 genes expression variations on cerebellum of BALB/c mice before and after birth under mobile phone radiation exposure. Iranian journal of basic medical sciences. 2017;20(9):1037.
22. Kouchaki E, Motaghedifard M, Banafshe HR. Effect of mobile phone radiation on pentylenetetrazole-induced seizure threshold in mice. Iranian journal of basic medical sciences. 2016;19(7):800.
23. El-Gohary OA, Said MA-A. Effect of electromagnetic waves from mobile phone on immune status of male rats: possible protective role of vitamin D. Canadian journal of physiology and pharmacology. 2017;95(2):151-6.
24. Fakhr Yasseri A, Saatchi M, Abedi Yarandi V. Optimal Time of Ureteral Catheter Removal after Retrograde Intrarenal Surgery. Translational Research Urology. 2021;3(2):54-8.
25. Fakhr Yasseri A, Taheri D. Measuring Stone Free Rate after Mini Percutaneous Nephrolithotomy: Radiography, Ultrasound, or CT scan? Translational Research Urology. 2020;2(2):48-50.
26. Khatami F, Guitynavard F. Cornus Mas and Urinary Tract Infections Treatment. Translational Research Urology. 2020;2(1):9-11.
27. Chaussy C. The use of shock waves for the destruction of renal calculi without direct contact. Urol Res. 1976;4:175.
28. Eisenberger F. EXTRAKORPORALE ANWENDUNG VON HOCHE NERGETISCHEN STOSSWELLEN-EIN NEUER ASPEKT IN DER BEHANDLUNG DES HARNSTEINLEIDENS. 1977.
29. Chaussy C, Schmiedt E, Jocham B, Brendel W, Forssmann B, Walther V. First clinical experience with extracorporeally induced destruction of kidney stones by shock waves. The Journal of urology. 1982;127(3):417-20.
30. Chaussy C, Schmiedt E, Forssmann B, Brendel W, editors. CONTACT FREE RENAL STONE DESTRUCTION BY MEANS OF SHOCK-WAVES. European Surgical Research; 1979: KARGER ALLSCHWILERSTRASSE 10, CH-4009 BASEL, SWITZERLAND.
31. Cao L, Wang Y-q, Yu T, Sun Y, He J, Zhong Y, et al. The effectiveness and safety of extracorporeal shock wave lithotripsy for the management of kidney stones: A protocol of systematic review and meta-analysis. Medicine. 2020;99(38).
32. Samplaski MK, Irwin BH, Desai M. Less-invasive ways to remove stones from the kidneys and ureters. Cleve Clin J Med. 2009;76(10):592-8.
33. Aghamir SMK, Mohseni M, Arasteh S. Intravesical Bacillus Calmette-Guerin for treatment of refractory interstitial cystitis. 2007.
34. Aghamir SMK, Mojtahedzadeh M, Meysamie A, Atharikia D, Izadpanah F, Sheikhvatan M. Comparison of systemic stress responses between percutaneous nephrolithotomy (PCNL) and open nephrolithotomy. Journal of endourology. 2008;22(11):2495-500.

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