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Original Research Article

Evaluation of Cortico - Medullary Differentiation of Lithotripsy Patients using Ultrasound in Sudan

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Abstract: This is an observational cross-section study conducted in Khartoum state Sudan, it aimed to evaluate the kidneys Ultrasound scans of renal stone patients who underwent lithotripsy treatment. The kidneys of 156 patients were evaluated post sessions using the Cortico-medullary differentiation as an indicator to the wellbeing of the kidney, the study considered the age, gender, number, location and size of stones and number of extra corporal shock wave lithotripsy (ESWL) sessions. The kidneys were scanned by real time ultrasound represent the classes of the study in the period from March 2016 to August 2016. The scans were scored by an expert sonologist. Then all the variables were analyzed by statistical package of social studies (SPSS) to obtain the central age group and the mean stone size. The results of this study showed that age group prone to develop stones 39-48 with higher prevalence in males and the solitary stone is the commonest and the right lower pole to be the most likely affected, most of patient had one session of ESWL and their Cortico-medullary differentiation were preserved. The only common side effect was hydronephrosis. None of the patients had perirenal collection or renal scar. The study observed that as age increases stone size decreases by 0.005cm/year. The study found correlation between the increasing number of ESWL and the effect of the renal Cortico-medullary differentiation (CMD). In conclusion, complications after SWL are mainly connected to the formation and passage of fragments, infections, the effects on renal and non-renal tissues, and the effects on kidney function. Each of these complications can be prevented adopting appropriate measures, such as the respect of the contraindications and the recognition and the correction of concomitant diseases or infection, and using the SWL in the most efficient and safe way, tailoring the treatment to the single case. The study recommend that the patients are evaluated immediately after the sessions and again sooner the standard three weeks post session, for more accurate and thrill evaluation for hematomas and other side effects which can subside with time.
Keywords: Cortico - Medullary Differentiation, Extra corporal shock wave lithotripsy and Lithotripsy

INTRODUCTION

Lithotripsy is a medical procedure involving the physical destruction of hardened masses like kidney stones [1]. Bezoars [2] or gallstones. The term is derived from the Greek words meaning "breaking (or pulverizing) stones" [1].

Another specific term for Lithotripsy is Extra corporal shock wave therapy (ESWL) was first used on kidney stones in 1980 and is applied to gallstones and pancreatic stones. External shockwaves are focused and pulverize the stone which is located by imaging. The first shockwave lithotripter was the Dornier HM3, a device for testing aircraft parts. Second generation devices used piezoelectric or electromagnetic generators. American Urological Association guidelines consider ESWL a potential primary treatment for stones less than 2 cm [1].

Shock wave lithotripsy (SWL) has proven to be a highly effective treatment for the removal of kidney stones. Shock waves (SW's) can be used to break most stone types, and because lithotripsy is the only non-invasive treatment for urinary stones SWL is particularly attractive. On the downside SWL can cause vascular trauma to the kidney and surrounding organs.

This acute SW damage can be severe, can lead to scarring with a permanent loss of functional renal volume, and has been linked to potentially serious long-term adverse effects. A recent retrospective study linking lithotripsy to the development of diabetes mellitus has further focused attention on the possibility that SWL may lead to life-altering chronic effects [1]. Thus, it appears that what was once considered to be an entirely safe means to eliminate renal stones can elicit potentially severe unintended consequences. The purpose of this review is to put these findings in perspective. The goal is to explain the factors that influence the severity of SWL injury, update current understanding of the long-term consequences of SW damage, describe the physical mechanisms thought to cause SWL injury, and 2 introduce treatment protocols to improve stone breakage and reduce tissue damage [1].

Shock wave lithotripsy employs high energy acoustic pulses (shock waves) generated outside the body to break stones within the kidney and ureter. As such SWL is the only non-invasive method available to remove stones. In the early years following its introduction SWL was considered an option for the treatment of virtually any stone type in any anatomical location. Urologists soon learned, however, that the urinary tract has a limited ability to clear stone fragments and that ureteric obstruction could occur if the mass of stone debris was too high. As such SWL is now used to treat otherwise uncomplicated solitary stones, or a combined stone burden of less than 2 cm (on KUB), located in the upper urinary tract (renal pelvis or proximal ureter) [2]. Not all mineral types respond well to SW's. Some calcium oxalate monohydrate stones, brushite stones and a sub-type of cystine can be highly SW-resistant [3]. A noteworthy drawback of SWL is that in many cases stone fragments left behind can serve as foci for the development of new stones [4]. As such, stone free rates are lower and stone recurrence rates are higher for SWL than with invasive protocols such as ureteroscopy and percutaneous nephrostolithotomy that involve visual localization and extraction of stones [5]. Still, because lithotripsy can be very effective, is non-invasive and is typically performed on an outpatient basis, SWL is used for the treatment of up to 70% of uncomplicated upper tract stone cases [6].

Lithotripters differ from one another in the method used to generate SW's (i.e. electromagnetic EML, electrohydraulic EHL spark gap, piezoelectric array), but they are largely the same in that they all produce a very similar acoustic pulse [7]. Even though lithotripter SW's are quite powerful it can take hundreds, even thousands of pulses to reduce stones to particles fine enough (~2 mm) to be voided through the urinary tract. Breakage tends to be gradual and stones fail by a process of fatigue due to repetitive stress [8, 9]. Shock waves create micro cracks 3 that progressively lengthen and expand until failure occurs. A variety of mechanisms have been proposed to explain how SW's break stones, but in simple terms this amounts to two main events, cavitations and direct stress [7].

Cavitation is the formation of bubbles in the urine surrounding the stone, and is driven by the negative pressure phase of the SW. Bubble growth is rapid and collapse can be particularly forceful, generating powerful secondary SW's that radiate from the point of collapse and fluid micro jets that produce intense, focused pressures directed at the surface of the stone. Cavitations bubbles form clusters and collapse together to erode the surface of the stone [10]. Cavitation may contribute to all phases of the progressive breakage of stones but appears to be most important in grinding down stone fragments that are too small to be broken by other mechanisms [11]. Thus, cavitation is critical to stone comminution, but also plays a major role in causing tissue damage [12].

A number of clinical studies have suggested that new-onset hypertension is a potential long-term consequence of ESWL [13-15]. Among these, one prospective study showed age as a significant risk factor, with an increase in intra renal resistive index in patients 60 years of age and older [16,17]. Other studies as well have reported an increase in hypertension among older lithotripsy patients [18]. It appears that transient hypertension can result from formation of sub capsular hematomas [19]. Potential mechanisms for long-term effects have not been determined, although there is a report of mesangial cell proliferation in experimental work with pigs at one month post-SWL [20].

Kidney stone disease is not a simple problem, and there is ample evidence to show that stone formation involves multiple etiologies [21]. Indeed, it is appropriate to refer to specific stone disease entities such as brushite disease or cystine stone disease in comparison for example, two of idiopathic calcium oxalate (CaOx) stone disease [22, 23]. One piece of this story follows the observation that over the past three decades there has been an increase in the occurrence of calcium phosphate (CaP) stones within the population [24]. A4 potential explanation for this shift has been difficult to find. That is, until it was recently observed that a correlation exists between percent CaP in stones and the number of lithotripsy sessions in the cohort [24]. The data showed that CaP stone formers underwent a greater number of lithotripsies than did CaOx stone formers, and patients with brushite stones underwent SWL more than either of these groups. This may suggest the possibility that SWL is linked to a transition from CaOx disease to brushite disease, a change toward a more complicated pathology [22]. The implication is that multiple lithotripsies for the treatment of CaOx stones may cause progressive injury in the renal papilla that alters the normal physiology of the collecting ducts, and fuels the formation of intraluminal crystalline deposits of apatite a process that typically involves tubular atrophy, even papillary necrosis. Thus, multiple lithotripsies could be driving the formation of brushite, a mineral type that does not respond well to SW's, and is often considered a contraindication for SWL [22].

OBJECTIVES OF THE STUDY

To evaluate the cortico-medullary differentiation of patients who underwent lithotripsy using ultrasound, (to explore the possible effects and disadvantages).

MATERIALS AND METHODS

This is an observational descriptive cross sectional study; the study was conducted in Mawada and Alneilin Hospitals, departments of Lithotripsy and Ultrasound. The ESWL and ultrasound units are referral clinics for patients from different regions of Sudan. Being referral clinics this makes the sample to be a reliable representation of the Sudanese population through those who came during the specific duration of the study. Sample size and Sampling Procedure, convenient sampling technique was used because it will be difficult to randomize the sample being a clinic based study.

Inclusion criteria, patients with renal stones and on ESWL sessions, patient on regular treatment and follow up and we exclude patients with associated disease that could alter the CMD like diabetes and renal vascular diseases, patients with extreme hydronephrosis and patient in whom other abnormality detected (such as masses, pyelonephritis and renal parenchymal diseases). The study variables includes age, gender, stone size, number of sessions, stone location within the kidney, presence or absence of hydronephrosis, renal scar, perirenal collection, parenchymal thickness and cortico-medullary differentiation.

They were patients who are diagnosed with renal stones and are referred to the lithotripsy unit and underwent sessions. The data was collected from 156 patient suffered from renal stones and on ESWL treatment with different number of sessions fulfilling the inclusion and exclusion criteria. Data acquisition and technique, after ESWL sessions we scanned the patients in supine position then long axis and short axis are made for the right and left kidneys, the decubitus positions (Right & Left) are also be used to aid the imaging. All data was collected from the ultrasound scans of patients after ESWL sessions, findings and patient information was recorded on data collection sheets and analyzed using SPSS (statistical package of social studies).

RESULTS AND DISCUSSIONS:

Extra corpal shock wave lithitropsy is a very commonly used treatment modality for appropriates sized stones. Even though it is a noninvasive treatment technique major complication may occur following SWL sessions. Urinary stone management has evolved over the last 30 years. Minimally invasive techniques can now be performed for urinary stones in almost all situations. ESWL treatment is generally recommended as the first-line treatment by most guidelines for intrarenal calculi of $\leq$ 20 mm and some ureteral calculi of $<$ 10 mm [9, 13]. ESWL shows many potential advantages over other procedures because it provides an anesthesia-free, technically less demanding, noninvasive, and effective therapeutic modality with a low rate of.

In this study we scanned 156 ESWL treated patients at various times after the lithotripsy sessions from immediate to three weeks. The general morphology of the kidney was noted along with the perinephric area. Our variables were the patient's gender, age, side and size of the stone and its location within the kidney itself. Also the presence and absence of hydronephrosis and its degree was evaluated. Our result showed male prevalence of the renal calculi disease (88 frequencies, Table 1). Gentlemen have more muscular works than females they sweet more move more which concentrate the urine and may lead to stone formation also they tend to ignore pain and doctor appointments more than the much caring ladies.

The age group 39-48 (Table 2) is the most prone one. These individuals are middle aged people and would be candidates for the chronic illnesses. In other words they are aging after an active life. The statistics also showed that as age increases stone size decreases by 0.005cm/year (Table 10). This can be explained by the fact that young people do not often get regular medical checkups unless they suffer from sudden onset of pain or acute condition, while the elder group has most likely chronic illnesses and other reasons to get tested or scanned so the stones will be detected when it is small and perhaps with no or minimal complications. We can say that older individuals take better care of their health or at least their guardians do that for them. The right kidney was the most common side (frequency of 81 Table.3). Compared to the left which had a frequency of 75 it is a close range.

The lower pole of the kidney has the commonest location (frequency of 101, Table 5). We can explain that with the gravity and the component of the stone it's logical that it descend to the lower pole and concentrate there. The most common stone number was one followed by multiple, then two stones (Table 4) we can relate this to the process of cavitations and the breaking down of stones into smaller fragments, so this was expected during the course of treatment. Also solitary stones can cause acute renal colic and be detects much earlier. The cortico-medullary differentiation was not preserved in 28 patients (Table 6), with the increase of number of sessions the CMD tends to be not preserved (Table 7) It is expected to have more side effects with increasing number of sessions.

The parenchymal thickness was normal in 129 decreased in 29 and increased in only 1 patient (Table 8). The ultrasound scans was done in different times after the ESWL sessions so hematomas and other transient effects could have been subsided or it could be never occurred. With increase in ESWL session hydronephrosis decreased (Table 9) this can be explained by the progress of treatment and relief from the cause of obstruction. Our study has similar result to the study by Sheir KZ in 2003. Extracorporeal shock wave lithotripsy has no deleterious effects on the renal function. Post- SWL obstruction, although transient, has a major effect on the renal function on the treated side and must be managed urgently. Shock wave lithotripsy alone induces minimal, reversible acute renal morphological changes and does not induce significant changes in renal perfusion. Post treatment obstruction has a major effect on renal perfusion on the treated side and must be ma naged urgently. Sheir KZ *et al.;* in 2014. The results of study by Carr *et al.;* in 1995 [4] suggest that extracorporeal shock wave lithotripsy is an effective and safe auxiliary procedure for managing residual stones after primary endoscopic surgery. This procedure is associated with a satisfactory stone-free rate and a low complication rate, particularly for residual stones after ureteroscopic procedures.

Table 1: Frequency distribution of patients' gender and stone

Gender	Frequency	Percent
Male	88	56.4
Female	68	43.6
Total	156	100.0

Table 2: Frequency distribution of patients' age and stone

age groups	Frequency	Percent
9-18	6	3.8
19-28	23	14.7
29-38	36	23.1
39-48	41	26.3
49-58	29	18.6
59-68	13	8.3
69-78	7	4.5
89-98	1	.6
Total	156	100.0

Table 3: Frequency distribution of stone side

Stone location	Frequency	Percent
Right	81	51.9
Left	75	48.1
Total	156	100.0

Table 4: Frequency distribution of number of stones

Stones No	Frequency	Percent
One	96	61.5
Two	21	13.5
Three(multiple)	39	25.0
Total	156	100.0

Table 5: Frequency distribution of renal stone and pole

Pole	Frequency	Percent
Upper	21	13.5
Middle	34	21.8
Lower	101	64.7
Total	156	100.0

Table 6: Frequency distribution of cortico medullary differentation

CMD	Frequency	Percent
Preserved	128	82.1
not preserved	28	17.9
Total	156	100.0

Table 7: Crosses tabulation of number of ESWL and CMD

No of ESWL	CMD		Total
	preserved	not preserved	
1	58	6	64
2	37	7	44
3	16	4	20
4	7	8	15
5	3	0	3
6	2	1	3
7	1	1	2
8	2	1	3
13	1	0	1
14	1	0	1
Total	128	28	156

Table 8: Frequency distribution of parenchymal thickness

Parenchymal thickness	Frequency	Percent
Normal	129	82.7
Increased	1	0.6
Decreased	26	16.7
Total	156	100.0

Table 9: Crosses tabulation of ESWL and Hydronephrosis

No of ESWL	Hydronephrosis			Total
	no	mild	Moderate	
1	36	18	10	64
2	26	8	10	44
3	10	6	4	20
4	5	7	3	15
5	1	1	1	3
6	2	1	0	3
7	1	0	1	2
8	2	0	1	3
13	0	0	1	1
14	1	0	0	1
Total	84	41	31	156

Table 10: Statistics of the central age group and the mean stone size

central age groups	mean stone size
13.5	0.171730769
23.5	0.411730769
33.5	0.870961538
43.5	0.6375
53.5	0.512884615
63.5	0.313846154
73.5	0.085961538
93.5	0.013461538

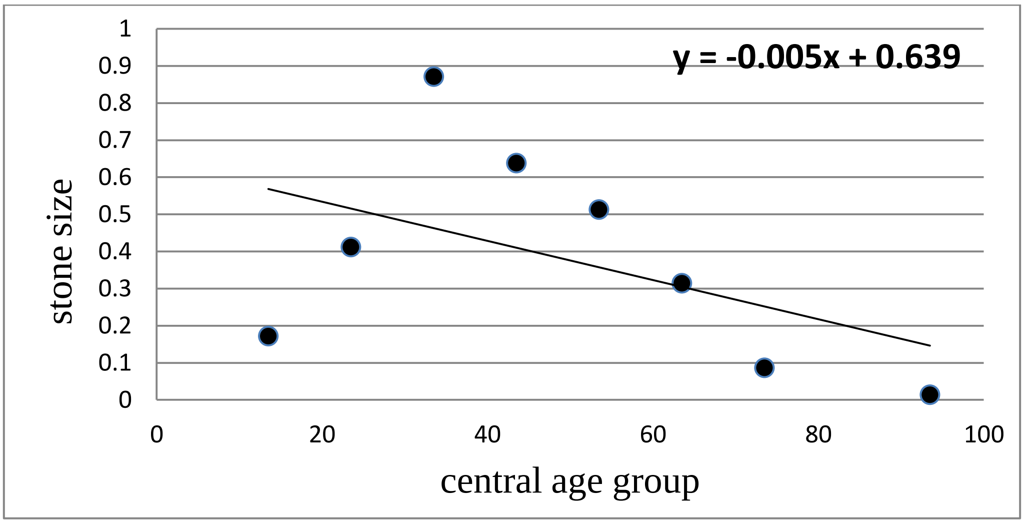

Fig 1: statistics of the central age gro7up and the mean stone size

As age increases stone size decreases by 0.005cm/year

CONCLUSION:

To identify the possible complications after extracorporeal shock wave lithotripsy (SWL) and to suggest how to manage them, the significant literature concerning SWL treatment and complications was analyzed and reviewed. Complications after SWL are mainly connected to the formation and passage of fragments, infections, the effects on renal and non-renal tissues, and the effects on kidney function. Each of these complications can be prevented adopting appropriate measures, such as the respect of the contraindications and the recognition and the correction of concomitant diseases or infection, and using the SWL in the most efficient and safe way, tailoring the treatment to the single case. In conclusion, SWL is an efficient and relatively noninvasive treatment for urinary stones. However, as with any other type of therapy, some contraindications and potential complications do exist. The strictness in following the first could really limit the onset and danger of the appearance of others, which however must be fully known so that every possible preventive measure is implemented. Shock wave lithotripsy has no major detectable renal damage if it is used efficiently and properly. It does not affect the CMD of the kidney which is an indirect indicator of the function of the kidney.

Recommendations:

Ultrasound scan must be performed at closer and steadier intervals such as immediately after the lithotripsy sessions, another one after 48 hours and after 10 days to catch any vascular damage or hematomas before they subside or resolve when the patient comes after the standard 3 weeks given at most hospitals. Patient should be instructed to come for immediate care if they felt any more paint or aggregation of symptoms. Some patient follows the current guide lines and come only after the 3weeks mean while stone fragment can be large enough to be impacted and cause progressive hydronephrosis. Urologist and ESWL operators should follow the upper and lower cut off point for the lithotripsy to avoid wasting of time and recourses as well as subjecting the patient to damage causing energy that could cause complications accompanied by other treatment such as surgery. CT number of the stone should be obtained and combined with the size to provide better estimation of the efficiency of the ESWL and minimize the waste of resources and prevent possible renal compromise.

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