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ECSWL – OPTIMUM STONE PARAMETERS ON NCCT FOR CALCULUS FRAGMENTATION

Urology

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ABSTRACT

For renal/ureteric calculi, different guidelines have been adopted to select patients for their utmost benefit from ESWL. Although size of the calculus is one of the important parameters, it alone cannot be considered the sole determinant anticipating ESWL success.

Methods: From January 2014 to January 2015, 78 patients diagnosed with renal/ureteric calculi using non contrast computerised tomography scanners were included in the study. For disintegration of calculi, maximum energy level of 2, 2500 shocks for renal and 3000 shocks for ureteric calculi in each session, at a rate of 60 SWs/min for renal and 90 SWs/min for ureteric calculi was used. Stone clearance was assessed every 2 weeks using x-ray or ultrasonography, upto a maximum of 3 sessions. ESWL success was defined as attaining a stone-free status or presence of <3mm fragment on ultrasonography or no visible radio-opaque shadow on x-ray.

Results: Of the 78 patients, 42 had renal and 36 had ureteric calculi. In patients with renal calculi, the diameter of the stone (mm) varied from 4.8 – 17, HU 147 – 1543.8, SSD (cm) 4.71 – 15.24. For ureteric calculi, diameter varied from 4.4 – 14mm, HU 256.8 – 1244.6 HU, SSD 8.6 – 15.3 cm. We could demonstrate that, with increasing HU (over 1000) and SSD (over 10 cm), there was increase in the number of sessions required for fragmentation.

Conclusion: With the advent of NCCT, the patient with optimum stone characteristics, who can benefit the most can be categorised. In our study, HU < 1000 and SSD < 10 cm achieved faster stone free status.

KEYWORDS

Kidney; ureter; urinary calculi; lithotripsy; computed tomography; x-ray

Introduction

Extracorporeal shockwave lithotripsy (SWL) was first introduced in 1980 by Chaussy et al[1] and was successfully applied to patients with urolithiasis[2]. It has become the standard treatment for renal and ureteral stones <2 cm in diameter. Compared with endo-urological intra-corporeal lithotripsy and open surgeries, SWL is a non-invasive method and has similar stone-free rates in appropriate patients. However, the success rates range from 46% to 91%[3,4,5] and failure of stone disintegration may cause additional delay, alternative procedures, and even complications such as steinstrasse and renal hematoma; therefore, to identify patients who will benefit from SWL prior to treatment is important.

For renal/ureteric calculi, different guidelines have been adopted to select patients for their utmost benefit from ESWL. Although size of the calculus is one of the important parameters, it alone cannot be considered the sole determinant anticipating ESWL success.

Methods

From January 2014 to January 2015, 78 patients diagnosed with renal/ureteric calculi using non-contrast computerised tomography scanners were included in the study.

For disintegration of calculi, maximum energy level of 2, 2500 shocks forrenal and 3000 shocks for ureteric calculi in each session, at a rate of 60 SWs/min for renal and 90 SWs/min for ureteric calculi was used.

Stone clearance was assessed every 2 weeks using x-ray or ultrasonography, upto a maximum of 3 sessions. ESWL success was defined as attaining a stone-free status or presence of <3mm fragment on ultrasonography or no visible radio-opaque shadow on x-ray.

Results

- January 2014 to January 2015, 78 patients diagnosed with renal/ureteric calculi
- Maximum of energy level of 2,
  1. 2500 shocks for renal, rate of 60 SWs/min and
  2. 3000 shocks for ureteric, rate of 90 SWs/min
- Stone clearance after 2 weeks, using x-ray or ultrasonography

Figure 1: Representation of percentage of renal and ureteric stones.

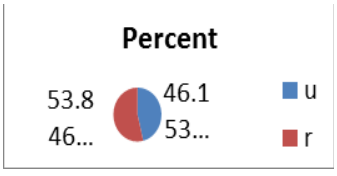


Table 1: Frequency

	Site	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Renal	42	53.8	53.8	53.8
	Ureter	36	46.2	46.2	100.0
	Total	78	100.0	100.0	

Table 2: Frequency Statistics

Site			Size (mm)	Mean HU	SSD (cm)	Shocks
Renal	N	Valid	42	42	42	42
		Missing	0	0	0	0
	Mean		9.02	654.24	8.43	2297.62
	Std. Deviation		2.57	285.21	2.08	456.117
Ureter	N	Valid	36	36	36	36
		Missing	0	0	0	0
	Mean		8.10	718.79	11.22	2486.11
	Std. Deviation		2.22	273.24	1.73	387.042

Table 3: Correlations

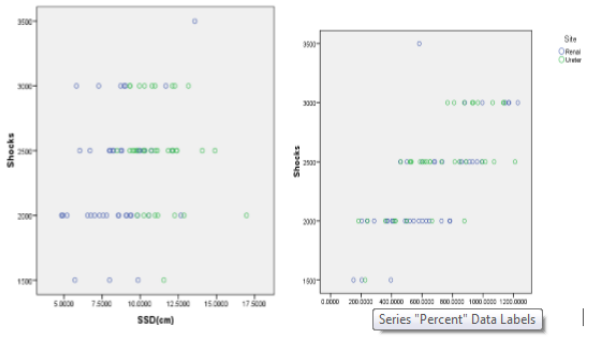
Site			Mean_HU	Shocks
Renal	Mean_HU	Pearson Correlation	1	.738**
		Sig. (2-tailed)		<0.001
		N	42	42
	Shocks	Pearson Correlation	.738**	1
		Sig. (2-tailed)	.000	
		N	42	42

Ureter	Mean_HU	Pearson Correlation	1	.704**
		Sig. (2-tailed)		<0.001
		N	36	36
	Shocks	Pearson Correlation	.704**	1
		Sig. (2-tailed)	.000	
		N	36	36
**. Correlation is significant at the 0.01 level (2-tailed).				

Table 4: Correlations

Site			SSD(cm)	Shocks
Renal	SSD(cm)	Pearson Correlation	1	.320*
		Sig. (2-tailed)		.039
		N	42	42
	Shocks	Pearson Correlation	.320*	1
		Sig. (2-tailed)	.039	
		N	42	42
Ureter	SSD(cm)	Pearson Correlation	1	-.181
		Sig. (2-tailed)		.290
		N	36	36
	Shocks	Pearson Correlation	-.181	1
		Sig. (2-tailed)	.290	
		N	36	36
*. Correlation is significant at the 0.05 level (2-tailed).				

Figure 2:



Results

Of the 78 patients, 42 had renal and 36 had ureteric calculi. Patients with renal calculi, the diameter of the stone (mm) varied from 4.8 – 17, HU 147 – 1543.8, SSD (cm) 4.71 – 15.24. For ureteric calculi, diameter varied from 4.4 – 14mm, HU 256.8 – 1244.6HU, SSD 8.6 – 15.3 cm. We could demonstrate that, with increasing HU (over 1000) and SSD (over 10 cm), there was increase in the number of sessions required for stone fragmentation.

Discussion

Determining the role of NCCT in predicting the stone-free rate in shockwave lithotripsy is important. Several studies have shown that NCCT provides a rapid assessment of the stone size, stone surface area, HU density, SSD, stone number, and stone location, and all these parameters have attempted to predict the success rate of SWL[6,7].

The main purpose of our study was to determine the stone parameters by NCCT for predicting the outcome after shockwave lithotripsy. There are several limitations in two-dimensional plain radiography to predict stone characteristics. For example, bowel gas and bony structures, may lower the accuracy of identification on plain radiography. NCCT is a safe, effective, and easily available technique, especially in the emergency department. It can eliminate the superimposition of images of structures outside the area of interest completely, and distinguish the differences between tissues that differ in physical density. Besides, data from a helical scan can be viewed as images in the axial, coronal, or sagittal planes, which provides multi-planar imaging. Currently, it has become more and more common for physicians to evaluate renal colic using NCCT, and it provides volumes of renal calculi with higher accuracy than excretory urography . NCCT identifies most urinary stones with an accuracy of >95%, and provides definite size and location of the urinary stone[8,9]

Skin-to-stone distance

The role of SSD on NCCT as a predictor of SWL was first established in 2005 . Pareek et al[10]. showed that the mean SSD was 8.12 ± 1.74 cm for the SWL success versus 11.53 ± 1.89 cm for the SWL failure ($p < 0.01$). The SSD threshold that best distinguished stones likely to fail SWL was 10 cm (odds ratio 0.32, $p < 0.01$)[10]. Several clinical studies have since verified that SWL failure is related to greater SSD[11,12].In our study, we demonstrated that SSD was a predictor of SWL success.

Stone attenuation

Recently Saw et al[13] first demonstrated that stone attenuation obtained by NCCT correlated with stone fragility. They found that the higher the attenuation value of stones, the greater the number of shockwaves needed for fragmentation[13]. Similarly, Pareek et al. Demonstrated that stone attenuation on NCCT can predict the stone-free rate after SWL. Stone attenuation not only correlated with the numbers of shockwaves required, but also associated with the sessions of shockwave treatment needed. A clinical retrospective study showed that among patients with urinary stone attenuation number >750 HU, 74% of them required at least three SWL sessions to achieve stone clearance. On the contrary, in those with urinary stone attenuation number ≤750 HU, only 20% of these patients required at least three SWL sessions ($p < 0.001$)[14] . Since then, many clinical studies have verified the effect of stone attenuation in the stone-free rate after SWL[15,16] . Our study gives support to these findings.

There are some limitations in the present study. First, we did not assess the chemical composition of the retrieved calculus fragments. Several studies have shown that the calculi composed of brushite and cystine manifest difficult fragmentations by using SWL17. In an experimental study, Bellin et al[18] analyzed 100 urinary stones with different chemical composition and showed that the CT stone attenuation value accurately predicts the chemical composition of 64–81% of urinary calculi. The attenuation profiles among main subtypes of urinary calculi showed uric acid 386 ± 154 HU, cystine 527 ± 110 HU, struvite 563 ± 169 HU, calcium oxalate dihydrate 723 ± 131 HU, hydroxyapatite 803 ± 203 HU, and calcium oxalate monohydrate and brushite 837 ± 220 HU . Third, the outcome of SWL was recorded by plain radiography or ultrasonogrpaphy, 2 weeks after treatment. Some stones may be exhausted 1 month later. The present study provides strong evidence that stone size, stone attenuation, and SSD and distribution could affect stone clearance after SWL treatment.

Conclusion

In the present study, Skin to stone distance , stone attenuation were independent predictors for stone-free rates after SWL.With the advent of NCCT, the patient with optimum stone characteristics, who can benefit the most can be categorised. In our study, HU < 1000 and SSD < 10 cm achieved faster stone free status. . Consequently, we can use these predictors for selecting the optimal treatment for patients with urinary stones.

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