ORIGINAL ARTICLE

Diagnostic Accuracy of Non-Enhanced Computed Tomography in Determining the Outcome of Extra-Corporeal Shock Wave Lithotripsy for Urinary Calculi

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ABSTRACT

Aim: To determine the diagnostic accuracy of non-enhanced computed tomography in determining the success of extra-corporeal shock wave lithotripsy.

Methods: This cross-sectional survey was conducted at Department of Diagnostic Radiology, The Children's Hospital, Lahore in collaboration with the Department of Urology, Jinnah Hospital, Lahore from 15th February, 2014 to 15th August, 2014. All patients were collected from Urology Outdoor department, The Children's Hospital, Lahore. All patients had to do NECT before EWSL, CT is conducted with 3 mm continuous axial sections through the renal calculus, using the soft tissue setting of window width 250-300 HU and window level of 40 HU at 120 KV and 165 mA. Attenuation value of Calculus was taken in Hounsfield units and all patients were divided according to calculus attenuation values as (1) calculus having density ≤945 HU and (2) calculus having density >945 HU. All patients were undergone ESWL (Storz Medical Modulith SLX-F2). A maximum of 6.0 KV was given to each patient, starting at 0.5 KV and rising slowly stepwise following every 20 shock waves. Total six sessions were given, each after 15 days interval. During each ESWL session up to 3000 shock waves were given.

Results: Out of 180 patients, 91 (50.6%) were males and 89 (49.4%) were females with male to female ratio was 1:1.02. The mean ± standard deviation of age was 13.15±1.74 years. The sensitivity and specificity were 95% and 52.6% while PPV and NPV were 94.4% and 55.5% respectively. Overall diagnostic accuracy was 90.5%.

Conclusion: Renal calculus is an emergency condition in urology. Quick and timely mediation can save the life of patient and prevent complications like chronic renal failure.

Key words: Diagnostic accuracy, Non-enhanced computed tomography, Outcome, ESWL, Urinary calculi

INTRODUCTION

Renal stone disease is one of the common problems in tropical Asia. It accounts for 40% of renal problems in Pakistan, which is a country in the "stone belt"[1]. Non-enhanced computed tomography (NECT) is used to determine the density values of urinary calculi before extra-corporeal shockwave lithotripsy (ESWL)[2]. It may assist to foresee the end result of treatment. If there is probability of a poor outcome from ESWL in patients than substitute treatment is planned. This can be told by CT attenuation values to some extent. It can be done by calculating density of calculi. CT attenuation value can distinguish those calculi which will easily disintegrate and those calculi which will require more attempts of ESWL and can lead to failure of procedure[3].

A recent study showed that a stone with a density <500 HU has 100% chance of being resolved by ESWL while patients with density >1000 HU have "stone free" rate of 22.2%. Analyzing the sensitivity and specificity for different thresholds we observed that a density value of 945 HU is the best threshold to identify the ESWL boundaries, this threshold had sensitivity=85.35% and specificity=73.08%. These data showed that any patient who has a stone density higher of 945 HU has only 37.7% chance to have a successful ESWL[4]. Extra-corporeal shockwave lithotripsy has become main stay of treatment of symptomatic upper urinary tract calculi of <2 cm size in children, especially in older children[5].

When diagnosis of urinary calculi is confirmed then non-enhanced CT is useful in providing the data required for the treatment of calculus, size and site. Now CT attenuation value can help about its composite. It is quite helpful for urologist if composition of calculus is guessed then patients will be categorized and management is planned according to the density. Calculi composed of calcium oxalate show density of 812±135 HU, struvites show density of 614±12 HU and uric acid show density of 413±143 HU[6].

MATERIALS AND METHODS

This cross-sectional survey was carried out at Department of Diagnostic Radiology, The Children's Hospital, Lahore in collaboration with the Department of Urology, Jinnah Hospital, Lahore over a period of six months from 15th February, 2014 to 15th August, 2014 and comprised 180 cases. Age 11 to 16 years and solitary renal calculus measuring 5 mm to 20 mm on ultrasonography were included. Patients with congenital renal anomalies such as horse-shoe kidney, PUJ obstruction and ectopic kidney confirmed on ultrasonography, renal failure (serum creatinine level above 3 mg/dl) and bleeding disorders like hemophilia confirmed by medical record were excluded. All patients go through NECT before EWSL with 3 mm continuous axial sections through the renal calculus. On CT scan using the soft tissue setting of window width 250-300 HU and window level of 40 HU at 120 KV and 165 mA. The most extreme measurement and the mean thickness of the stone were

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computed by drawing an area of intrigue (ROI) over the calculs.

All patients were undergone ESWL (Storz Medical Modulith SLX-F2). The fragmentation of the calculus and the treatment was observed by ultrasonography. During the procedure maximum of 6.0KV was given to each patient. It is started at 0.5KV and progressively increased stepwise after every 20 shock waves. Total six sessions were given, each after 15 days interval. During each ESWL session up to 3000 shock waves were given. After each ESWL session ultrasound of kidneys, ureters and bladders were performed to document fragmentation. Same ultrasound is repeated before the next ESWL session for presence of fragments and determining its site. The success of ESWL is measured by the ultrasound as after ESWL renal calculus completely vanished at 3 months. The complete data was entered into the computer using SPSS version 20.

RESULTS

Out of 180 cases, 91(50.6%) were males and 89(49.4%) were females showing male predominance with mean age of 13.15±1.74 years (Table 1). The sensitivity and specificity values were 96.2% and 71.4% respectively. Overall diagnostic accuracy was 93.3% (Table 2).

Table 1: Frequency and percentage of age

Variable	No.	%
Gender		
Male	91	50.6
Female	89	49.4
Age (years)		
10 – 12	78	43.3
13 – 14	53	29.4
15 – 16	49	27.3

Table 2: Comparison of non-enhanced computed tomography (NECT) vs ESWL results

NECT	ESWL		Total
	Yes	No	
Yes	153 (TP)	6 (FP)	159
No	6 (FN)	15 (TN)	21
Total	159	21	180

$$\text{Sensitivity} = \frac{153}{153 + 8} \times 100 = 96.2\%$$

$$\text{Specificity} = \frac{15}{15 + 6} \times 100 = 71.4\%$$

$$\text{Accuracy} = \frac{153 + 15}{153 + 15 + 6 + 6} \times 100 = 93.3\%$$

DISCUSSION

The result of ESWL depends on fragmentation of the calculus and fragments clearance. Disintegration of a calculus mostly depends on size and composition[7]. To predict composition of calculus would help to increase the effectiveness of ESWL. Non-enhanced computed tomography is noninvasive procedure. It offers good density judgment than radiography; CT can detect a density difference of 0.5%, whereas plain radiography detect density difference of a 5%[8]. NECT show higher attenuation values of calcium oxalate and cystine calculi than uric acid or xanthine calculi.[9] Newhouse et al utilized NECT to decide CT constriction values for a precise investigation of stone arrangement; uric corrosive and cystine calculi could be recognized, however calcium-containing calculi, for example, struvite, brushite and oxalate couldn't be recognized dependably from each other[10].

Later, Saw et al[11] reported in an in vitro study, that the quantity of shock waves depends on the calculus size (volume, weight, diameter correlated) to fragment and also on helical CT attenuation values. It is decided for calcium calculi, the number of shock waves was reduced than half the CT attenuation value of cakculus.

Nakada et al[12] in an interesting in vivo study comparison of attenuation and attenuation size ratio with analysis of calculus is done; there was a substantial distinction between uric acid calculi (344±152 HU), and calcium oxalate calculi (652±490 HU), and by calculating a constriction/measure proportion edge of >80, the negative predictive value was 99% that an analytics would be overwhelmingly calcium oxalate.

Joseph et al[13] reported in an investigation of 30 patients, found that patients with calculi of <500 HU had complete clearance and required 2500 shock waves (median), while patients with calculi of 500–1000 HU had a clearance rate of 86% and required a median of 3390 shock waves, and patients with calculi of ≥1000 HU had a clearance rate of 55%, requiring a median of 7300 shock waves, previously studies have proposed that if the attenuation value of the calculus was >950 HU and 7500 shock waves had not accomplished acceptable fragmentation than treatment of percutaneous nephrolithotomy must be considered.

Extracorporeal shockwave lithotripsy outcome is influenced by calculus size, but density has a much bigger influence on the outcome as compared to size. Protective measures can be taken to reduce side effects of ESWL. Recent lithotripters are user softly, treatment is moderately painful, but it depends on selection and optimizing the treatment protocols. Which are needed to maximize "stone-free" rates and to minimize the side effects.

CONCLUSION

Outcome of patients with renal calculus is good, if early diagnosis is made and prompt treatment should be given on emergency basis. Non-enhanced computed tomography is a noninvasive method and performed before extracorporeal shockwave lithotripsy can help to determine stone density and thus its fragility and treatment outcome. Knowledge of stone density could help in arranging another treatment for patients with bad prognosis, increasing extracorporeal shockwave lithotripsy efficiency, reducing treatment costs, especially in patients with stone density higher than 1000 HU.

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