ORIGINAL ARTICLE

Hounsfield Units (HU) as a Predictor of Stone Clearance after Percutaneous Nephrolithotomy (PCNL)

MUHAMMAD AKHTAR[1], MUHAMMAD UMAR KHAN[2], ZEESHAN ZAFAR[3], SARFRAZ HASSAN[4], MUHAMMAD HAMZA KHAN LODHI[5], HAFIZ MUHAMMAD USMAN[6], MM KHAN[7]

[1]Assistant Professor of Urology, Multan Medical and Dental Collage Multan & Ibn-e- Sina Hospital & Research Institute, Multan.

[2,3,5,6]Urology Intern, Multan Medical & Dental College and Ibn-e-Siena Hospital & Research Institute, Multan.

[4] Assistant Professor of Urology, Department of Nephro-Urology and Renal Transplantation, BVH,QAMC Bahawalpur

[7]Professor NM&DC

Correspondence to: Dr. Muhammad Akhtar, Email: drakhtarmalik@gmail.com, Cell: 0300-9633251

ABSTRACT

Objective: To compare the outcomes of percutaneous nephrolithotomy (PCNL) in patients with renal stones with high (≥700) versus low (<700) HU.

Patients and Methods: A total of 200 patients having age 18 to 60 years, with diagnosis of unilateral renal stone disease, having stone size 2 to 4 cm in diameter on non-contrast computed tomography (NCCT) of Urology Unit of Ibn e Sina Hospital and Research Institute Multan were included. The study duration was May-2021 to July-2021. NCCT was done pre-operatively in every patient to measure Hounsfield units (HU). Post-procedural X-ray KUB was done 2 weeks after the surgical procedure to determine the stone clearance in every patient.

Results: Mean age was 45.79±11.17 Years. Mean duration of disease of patients included in this study was 8.78±8.59 months. Mean stone size in patients included in this study was 3.11±0.61 cm. On comparison of stone clearance rate between the patients having high-HU versus low-HU, stone clearance was found in 61 (72.6%) patients having low HU value and in 105 (90.5%) patients having high HU value (p-value 0.001).

Conclusion: HU-value ≥700 is a significant predictor of success rate of percutaneous nephrolithotomy (PCNL) in patients having renal stone disease.

Keywords: Renal Stone Disease, Percutaneous nephrolithotomy, Hounsfield units (HU).

INTRODUCTION

For the treatment of renal stones, percutaneous nephrolithotomy (PCNL) has been around since decades and is widely used. The success rate of PCNL for treating large or complex renal stones is higher than that of other minimally invasive treatments.[1,2] Due to recent advancements in PCNL techniques the complications rate has been reduced to be minimum while success rate has been increased.[3] The success rate of PCNL is measured in terms of complete clearance of renal stones. The reported success rate of PCNL varies from 50.0% to 100%.[4]

During PCNL procedures, fluoroscopy is utilized on a consistent basis for the purposes of entering the renal collecting system, evaluating renal anatomy, ensuring that surgical instruments are positioned appropriately, as well as watching and finding remaining stones.[5] Numerous research have been carried out in order to determine the elements that increase the likelihood of the PCNL technique failing. According to the findings of many studies, the most significant risk factors for the procedure's failure include the size of the stone, its placement, the patient's body mass index (BMI), the number of renal accesses, and a previous history of renal surgery.[6-8] Recent research has led scientists to the conclusion that Hounsfield units can also be used to forecast the results of surgery to remove kidney stones.[9,10]

The density of the stone or structure in question can be inferred from the Hounsfield units (HU), a metric derived from conventional CT. Stones in the urinary system can also be evaluated for CT density using HU. This has become an increasingly useful diagnostic tool in recent years, both for identifying the specific type of stone and for selecting the most effective treatment. Usefulness of HU in determining the outcomes of PCNL has been reported by some studies. The aim of proposed study is to determine the usefulness of HU in predicting the outcomes of PCNL.

METHODS

This comparative study included 200 patients of renal stones who were planned for PCNL from May-2021 to July-2021. The study was conducted in Urology Unit of Ibn e Sina Hospital and Research Institute Multan. Patients of age 18-60 years, having unilateral renal stones measuring 2 to 4 cm in diameter on NCCT were included. While patients with bilateral stones, having congenital renal anomalies, active urinary tract infection and having location of stones other than renal pelvis were excluded. Written Informed consent were taken from all the study patients.

Non-contrasted computed tomography (NCCT) were done pre-operatively in every patient to measure Hounsfield units (HU).

PCNL procedures was done by senior surgeons having experience of at least 5 years after fellowship. Post-procedural X-ray KUB was done 2 weeks after the surgical procedure to determine the stone clearance in every patient. All the collected information regarding stone clearance and other relevant information regarding patients age, gender, body mass index (BMI), duration of renal stone disease was recorded.

Data analysis was carried out using SPSS v20.0. Chi-square test was applied to determine the association of HU with stone clearance rate.

RESULTS

Mean age was 45.79±11.17 years. Mean duration of disease of patients included in this study was 8.78±8.59 months. Mean stone size in patients included in this study was 3.11±0.61 cm.

Regarding gender, there was male predominance in this study. There were 128 (64.0%) male patients and only 72 (36.0%) female patients (Figure 1).
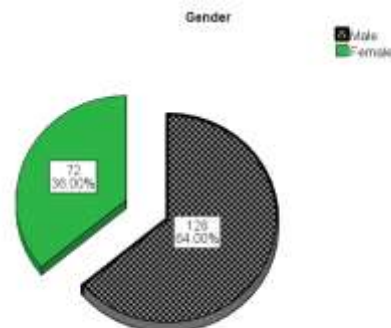

Figure 1. Frequency of Gender.

Stones were diagnosed in right kidney in 124 (62.0%) patients and in left kidney in 76 (38.0%) patients (Figure 2).

Successful stone clearance was achieved in 166 (83.0%) patients after PCNL.

Mean value of HU was 779.45±257.78 units. On comparison of stone clearance rate between the patients having high HU versus low HU values, stone clearance was found in 61 (72.6%) patients having low HU value and in 105 (90.5%) patients having high HU value. This difference in stone clearance rate was statistically significant with p-value of 0.001 (Table 1).
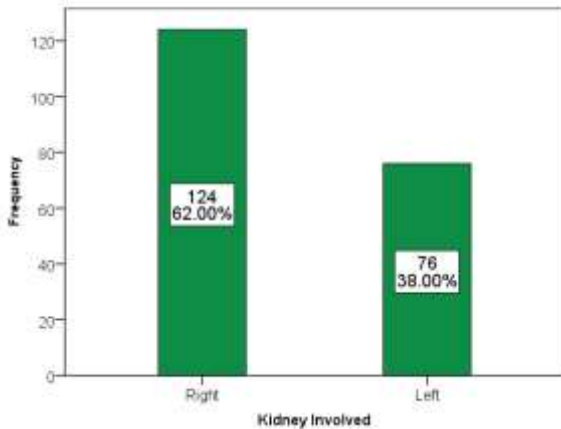

Figure 2. Frequency of Side of Kidney Involved.

Table 1. Comparison of Stone Clearance Rate in Patients with High (HU ≥700) versus Low (HU <700) Hounsfield Units.

Stone Clearance	Hounsfield Units		P-value
	Low (<700 HU)	High (≥700 HU)	
Yes	61 (72.6%)	105 (90.5%)	0.001
No	23 (27.4%)	11 (9.5%)	

DISCUSSION

The degree of opacification on the KUB film can be used to radiologically analyze kidney stones. The KUB film can identify most stones since they are radio opaque, but estimating stone density based on KUB film opacification is a somewhat arbitrary method that does not rely on a quantitative technique like NCCT. NCCT is used to calculate the HU value to determine the stone's density.[11]

According to numerous researches, calculating the HU value with the help of NCCT is a crucial step in determining how well SWL will work. El-Assmyet al. stated that stones with a HU >1000 were challenging to fragment through SWL and recommended an alternative treatment strategy in such circumstances.[12] The HU value and the quantity of shock waves necessary to shatter the stones were shown to be positively correlated, according to Joseph et al.[13] Pareeket al. found in three separate investigations that when the HU value increased, the likelihood of remaining stones following SWL increased as well. Gupta et al. conducted an investigation into the effectiveness of SWL and based their findings on the HU value. They discovered that in their high-HU group, where the stone-free rate was 60%, 77% of patients required three sessions of SWL.[14] According to Wang et al., there is a higher incidence of failure SWL when the stone's density and volume are both greater than 900 HU and 700 mm, respectively.[15] According to Saw et al., a helical CT taken prior to the SWL could be used to predict the effective shock wave dose.[16]

In this study, we demonstrated that the HU ≥ 700 is a predictor of success rate of PCNL, while HU values <700 are associated with higher risk of failure of PCNL. In present study, stone clearance was found in 61 (72.6%) patients having low-HU and in 105 (90.5%) patients having high-HU.

Fluoroscopic imaging is utilized extensively in PCNL in order to offer an access to the collecting system as well as to determine the location of any residual stones that may be present. In fluoroscopic imaging, it is difficult to detect stones that have a low degree of opacity on plain radiography. It is likely that fluoroscopic imaging will not be able to detect an opaque agent if even a small amount of it escapes from the collecting system while it is being dilated.[17]

A properly planned and executed preoperative course of action as well as an effective percutaneous intervention are both prerequisites for a successful PCNL. For this reason, computed tomography (CT) has emerged as an essential imaging technique for the planning of typical pre-PCNL intervention. In a study about percutaneous nephrolithotomy (PCNL) in pediatric patients, Gedik and associates documented that regular CT before PCNL is required in order to detect the retrorenal colon and provide the most comfortable access.[18] This was found to be the case in the study. In addition to this, it has been observed that planning access by CT results in higher success rates. The ability to determine the HU level, which is an objective and quantifiable measure of stone opacity, is another another contribution that may be attributed to CT imaging. This contribution is suggested by the arguments that have been presented previously.[19]

One published study that is quite similar to the current study was carried out by Gücüket al. They did a retrospective assessment of the data for 179 patients who had PCNL, looking at the association between the HU value and the success rate of PCNL. They found that the likelihood of a stone remaining in the patient's urinary tract was 2.65 times higher in the group with a low stone density compared to the group with a high stone density. This was due to the fact that a higher stone density resulted in a lower surgical success rate. Despite this, they did not find any evidence of a link (p > 0.05) between the length of time required for the operation and the time spent undergoing fluoroscopy.[9]

Another study conducted by Gok et al. compared the stone clearance rate in patients having high HU (>1000) and low HU (≤ 1000). These authors did not found any significant difference in stone clearance rate of patients between the groups. In their study stone clearance rate was 91.9% patients having high-HU value and in 91.3% patients having low-HU value taking a cut off value of 1000 HU.[20]

CONCLUSION

HU-value ≥700 is a significant predictor of success rate of percutaneous nephrolithotomy (PCNL) in patients having renal stone disease.

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