Is There a Threshold of Body Mass Index for to Predict Extracorporeal Shock Wave Lithotripsy Success?

Original Research JCAM

Ekstrakorporeal Şok Dalga Litotripsi Başarını Öngörmede Bir Vücut Kitle İndeksi Eşik Değeri var mı?

Body Mass Index and Stone Disease

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Özet

Amaç: Vücut kitle indeksinin (VKİ) ekstrakorporeal şok dalga litotripsi (SWL) başarısı üzerine olan etkisini ortaya koymak. Gereç ve Yöntem: 1.5 cm'den küçük böbrek taşı için SWL olan tüm hastalar retrospektif olarak tarandı. Hastaların demografik bilgileri, boyları, kiloları ve taş karakteristikleri kaydedildi. Taşsız ve rezidü taşı olan hastalar VKİ, ortalama Hounsfield Unitesi (HU), taş boyutu ve sayısı ve şok dalga süresine göre karşılaştırıldı. Bulgular: Ortalama yaşı 48.17 ± 1.58 yıl ve ortalama taş boyutu 9.54 ± 1.61 mm olan 100 hasta çalışmaya dahil edildi. Genel SWL başarısı %69 iken 31 hastanın rezidü taşı vardı. Taşsızlık üst kaliks taşlarında %85, orta kaliks taşlarında %57.1, alt kaliks taşlarında %58.1 ve renal pelvis taşlarında %78.6 oranında sağlandı. VKİ ve ortalama taş boyutu taşsız ve rezidü taş gruplarında anlamlı olarak farklıydı [sırasıyla 25.3 ± 3.5 kg/m^2'e karşın 30 ± 3.4 kg/m^2, 8.7 ± 1.3 mm'e karşın 9.7 ± 1.6 mm (p< 0.001)]. Youden's indekse göre başarılı bir SWL için VKİ eşik değeri 26.75 kg/m2 olarak bulundu. Tartışma: Bu ön çalışma SWL başarısını öngörmek için bir VKİ eşiği ortaya konmasına öncülük edebilir.

Anahtar Kelimeler

Böbrek Taşı; SWL; Vücut Kitle İndeksi

Abstract

Aim: We aimed to determine the impact of BMI (body mass index) on extracorporeal shock wave lithotripsy (SWL) success. Material and Method: We retrospectively analyzed the medical records of all patients who underwent SWL for single renal stone smaller than 1.5 cm. Patient demographics, height, weight and stone characteristics were recorded. Stone free (SF) patients and patients with residual stone (RS) were compared according to BMI, mean HU (Hounsfield unit), stone size and number and duration of shock waves. Results: A total of 100 patients with an average age of 48.17 ± 1.58 years and an average stone size of 9.54 ± 1.61 mm were included the study. Overall SWL success was 69 % such 31 patients had RS. SF status achieved in 85%, 57.1%, 58.1% and 78.6% of patients with renal stones in upper, middle, lower calyces and renal pelvis, respectively. Mean BMI and mean stone sizes were found significantly different between SF and RS groups, 25.3 ± 3.5 kg/m^2 versus 30 ± 3.4 kg/m^2, 8.7 ± 1.3 mm versus 9.7 ± 1.6 mm, respectively (p< 0.001). The best cut-off value, which was found according to Youden's index, for BMI for a successful SWL was 26.75 kg/m^2. Discussion: These preliminary results may lead further studies with large patient numbers to determine a threshold of BMI for to predict SWL success.

Keywords

Nephrolithiasis; SWL; Body Mass Index

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Introduction

With the development of technology extracorporeal shock wave lithotripsy (SWL) has emerged as the first choice of treatment in renal calculi smaller than 2 cm over 3 decades [1,2]. SWL procedure has many advantages such as it is minimally invasive, has low complication rates and can be performed on an outpatient base [3]. Prediction of stone fragmentation is critical to avoid waste of time and money. Some well-described factors related to patient and stone are known to be associated with effective renal stone fragmentation. These factors are stone burden, localization, stone size and density, skin to stone distance, skeletal and renal anomalies, calyx diverticula and BMI [3,4]. Obesity affects more than 1.5 billion people worldwide as was proven to be associated with hypertension, diabetes mellitus, ischemic heart disease and urinary stone disease [5,6]. There is a limited study in the literature showing obesity as an independent predictor of SWL treatment success [5]. In this original study we aimed to determine the impact of BMI on SWL treatment success.

Material and Method

We retrospectively analyzed the medical records of all patients who admitted to urology clinic between 1 May 2014 and 1 November 2015 with single renal stone smaller than 1.5 cm and underwent SWL. Patients with a history of SWL failure were excluded from the study. Patient demographics, height, weight, stone history, stone size, stone localization and Hounsfield (HU) unit, SWL duration and number of shocks were recorded. All patients were evaluated with low-dose non-contrast enhanced computerized tomography (NCCT) before and with either NCCT or KUB (kidney-ureter-bladder) radiograph one month after SWL. Mean Hounsfield unit (HU) on NCCT was used to calculate stone density. Patients with stones ≤ 2 mm after SWL were assumed SF. Patients were stratified into two groups based on stone free (SF) status. SF patients and patients with residual stone (RS) were compared according to BMI, stone location, mean HU, stone size and number and duration of shock waves. SWL was performed with Stonelith V3 Lithotriptor (PCK, Turkey) on an outpatient base. Initial energy was 10kV, gradually increased by 0.5 kV to a maximum level of 21kV.

Statistical Analysis

Statistical analysis was performed via an available licensed statistic programme. Chi-square test was used to determine the difference of age, stone site, stone localization and HU between groups as well as Mann Withney U test for BMI, stone size and number and duration of shock waves. ROC curve analysis and Youden's index was used to find a cut-off. $P < 0.05$ was considered significant in statistical analysis.

Results

In total of 100 patients with an average age of 48.17 ± 1.58 years and an average stone size of 9.54 ± 1.61 mm were included the study. 65 patients were male and 35 were female. 51 renal stones were left-sided whereas 49 were right-sided. Number of patients within stones in upper calyces, middle calyces, lower calyces and renal pelvis were 20, 21, 31 and 28, respectively.

Overall SWL success was 69% such 31 patients had residual stones (RS). In comparison, no statistically significant difference was found between SF and RS groups according to sex, stone side and stone localization (p= 0,94; p= 0,34; p= 0.082).

Stone-free status achieved in 85%, 57.1%, 58.1% and 78.6% of patients with renal stones in upper, middle, lower calyces and renal pelvis, respectively. SWL success in patients with renal stones in the upper calyces and the renal pelvis was higher than patients with renal stones in middle or lower calyces, which was statistically not significant (p = 0.082) [Table 1].

Mean BMI and mean stone sizes were found significantly different between SF and RS groups, 25.3 ± 3.5 kg/m^2 versus 30 ± 3.4 kg/m^2, 8.7 ± 1.3 mm versus 9.7 ± 1.6 mm, respectively ($p< 0.001$).

The best cut-off value, which was found according to Youden's index, for BMI was 26.75 kg/m^2 with a sensitivity of 0.681 and a specificity of 0.839 [Area Under Curve (AUC)= 0.83 and $p< 0.001$]. (Figure 1).

And also no significant difference was noted between SF group and RS group related to HU (599.8 ± 80 versus 607.6 ± 77), shock number (2188 ± 334 versus 2232 ± 317) and procedure duration (31.3 ± 2.6 min versus 32 ± 2.2 min). ($P > 0.05$; p= 0,28; p= 0,16).

Discussion

Extracorporeal shock wave lithotripsy has been widely used since 1980's. It is suggested as first line-treatment in urinary tract stones in several guidelines [1,7]. Reported overall stone-free status rate is approximately 80-90%. It stands out as an alternative treatment choice because it is less invasive than percutaneous nephrolithotomy and ureterorenoscopy. Treat-

Table 1. Comparison Of Stone-free Status According to Stone Localization

			Stone-free Status		Total
			No	Yes	
Stone location	Upper Calyces	Count	3a	17a	20
		% Within stone location	15.0%	85.0%	100.0%
		% Within stone-free status	9.7%	24.6%	20.0%
	Middle Calyces	Count	9a	12a	21
		% Within stone location	42.9%	57.1%	100.0%
		% Within stone-free status	29.0%	17.4%	21.0%
	Lower Calyces	Count	13a	18a	31
		% Within stone location	41.9%	58.1%	100.0%
		% Within stone-free status	41.9%	26.1%	31.0%
	Renal Pelvis	Count	6a	22a	28
		% Within stone location	21.4%	78.6%	100.0%
		% Within stone-free status	19.4%	31.9%	28.0%
Total		Count	31	69	100
		% Within stone location	31.0%	69.0%	100.0%
		% Within stone-free status	100.0%	100.0%	100.0%

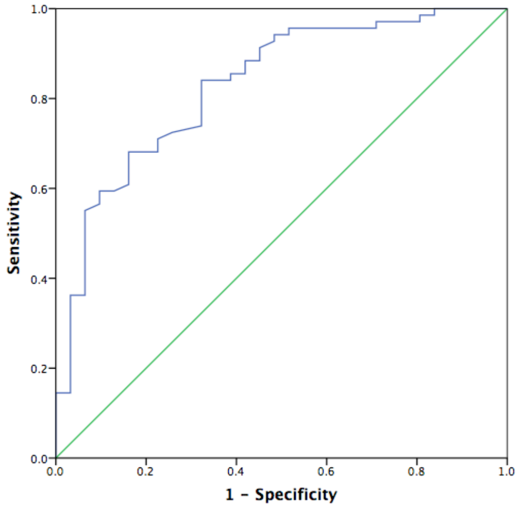

Figure 1. ROC Curve analysis to determine a cut-off value for BMI. Area Under Curve (AUC) is 0.830 (p <0.001). Smaller BMI values indicate stronger evidence for a stone-free status.

ment failure, additional treatment requirement and relatively long time to SF status are main limitations [8]. Therefore, prediction of treatment success is mandatory to determine the best treatment choice and to inform patient well.

Factors affecting SWL outcomes are being discussed over the past 20 years. Previous studies reported more favorable results in young patients and patients with low BMI and less stone burden [3]. In addition, upper pole, renal pelvis and proximal ureter stones represent more favorable results compared to lower pole and distal ureter stones [3]. In another study, hydronephrotic kidney was found associated with better SWL treatment success compared to non-dilated renal collecting system [9]. Abdel-Khalek et al.[10] also reported that stone size, stone localization and presence of ureteral stent affect SWL treatment success. In concordance, Shiroyanagi [11] was found stone size and stone localization as independent factors affecting SWL results. Many attempts have been made to develop nomograms in this regard. Kanao et al.[1] suggested that stone size, localization and number are predictive on SWL success and can be used in preoperative nomograms; whereas Pareek et al.[4] proposed BMI and HU as significant predictors of ESWL outcomes. HU is another frequently studied parameter in the assessment of stone density and fragility. In many studies, HU was found related with ESWL failure [12]. In other study, HU was found higher in RS group however statistical significant difference was not observed ($p > 0.05$). This might be due to some measurement biases deriving from the lack of a standardized measurement of HU on NCCT.

In the literature, stone burden is stated to have a significant effect on SWL success both in renal and ureteral stones [1,3]. Stone size was shown be a predictor of SWL success [8]. Abdel-Khalek et al.[13] found 89.7 % and 78 % of SF rates for stones <15 mm and >15mm, respectively. Similar to that, another study demonstrated 90 % success in stones <10mm and 70 % success in stones >10 mm [14]. In our study, a statistically significant difference was observed between SF and RS groups related to stone size, 8.7 ± 1.3 mm versus 9.7 ± 1.6 mm ($p < 0.001$). Ackerman et al.[15] suggested stone number to be more crucial than stone burden in ESWL and they attribute that to the difficulty of focusing in multiple stones.

In a study focused on stone localization, SF rates was found higher in upper pole and renal pelvis stones compared to lower pole stones [8]. According to these studies, stone localization, size and number seem to be significant in prediction of SF rate. Extracorporeal shock wave lithotripsy is reported to be a safe method in renal stone treatment up to 2 cm but we preferred opaque and single stones smaller than 1.5 cm to lessen disadvantages of stone burden and focusing problems. Patients were stratified in to four groups based on stone localization as upper calyces, middle calyces, lower calyces and pelvis groups. SF rates were higher in patients with upper calyces and renal pelvis stones compared to middle calyces and lower calyces stones. However, no significant difference was found in SF rates between these groups ($p = 0.082$). This might be due to low patient number and/or exclusion of stone between 1,5 and 2 cm. Significant results could be obtained in large series such our "p" value is very close to significance level.

Body mass index is widely used as a definitive and easily applied indicator of obesity. Generally accepted BMI ranges are normal weight from 18.5 to 25 kg, overweight from 25 to 30 kg and obese over 30 kg [4]. The association of BMI with lousy outcomes of several procedures was demonstrated in previous studies. However, effect of BMI on SWL results is not entirely clear. BMI and stone size were found related with SWL efficacy and also BMI was found a significant predictor of SF status ($p < 0.01$)[4]. In contrast, Takahara et al found an association between BMI and stone fragility ($p = 0.04$) whereas no relation was found in regard to SF status [8]. The factors acting in relation between BMI and SWL failure has not been entirely determined yet. Possible factors include difficulty in stone focusing and diminished shock waves during transition between the tissues [4]. Skin to stone distance is also reported to be an independent factor of SWL failure. Subcutaneous tissue is thought to absorb the shock wave energy and diminish the energy reaching the stone [3]. In our study, there was a significant difference between SF and RS groups according to BMI ($p < 0.001$). And the cut-off value of BMI was found to be 26.75 kg/m2 with a high positive prediction (AUC= 0.83). The difference in SF rates may suggest BMI as an independent predictor of SWL success. With the aid of further studies it might be possible to determine a threshold of BMI for to predict SWL success. By this way, patients could be informed about SWL success according to BMI before treatment and alternative treatment methods can be offered if necessary.

There are several factors effecting SWL success in urinary tract stones. In this study, we found BMI as a predictor of SWL success in opaque, single renal stones smaller than 1.5 cm with a cut-off value of 26.75 kg/m2. These preliminary results may lead further studies with large patient numbers to determine a threshold of BMI for to predict SWL success.

Compliance With Ethical Standards:

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Conflict of Interest: The authors declare that there is no conflict of interests regarding the publication of this manuscript.

Ethical Approval: All procedures performed in studies involving human participants were in accordance with the 1964 Helsinki

declaration and its later amendments or comparable ethical standards.
Informed Consent: Not required for this type of (retrospective) study.

Competing interests
The authors declare that they have no competing interests.

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