

# BODY MASS INDEX RELATIONS WITH THE DIFFICULTIES AND COMPLICATIONS OF PERCUTANEOUS NEPHROLITHOTOMY

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## ABSTRACT

**Objective:** To identify outcomes and complications of percutaneous nephrolithotomy (PCNL) in patients of various body mass indices (BMI) to determine the safety of this procedure in patients with elevated BMI. **Material & methods:** The analytic observational prospective study of patients who underwent PCNL between February to July 2015 in the operating room Soetomo General Hospital Surabaya. Specifically, BMI, stone-free rates, difficulties during surgery, complications, and Clavien score were assessed. We evaluate the independent contribution of BMI as a predictor of outcomes. **Results:** There were 35 selected patients with kidney stone and planned to PCNL, 20 patients were included and 15 patients were excluded from this study. The patients consisted of 10 men (50%) and 10 women (50%). Mean age was 47.55 years (range 33-75). There were 4 patients with diabetes (20%), and 10 patients with hypertension (50%). Mean stone size was 23.30 mm. Stone location was 11 patients (55%) in the right kidney, and 9 patients (45%) in the left. There were 12 patients (60%) with a single stone, and 8 patients (40%) with multiple stones. BMI values were distributed as follows, underweight 1 patient (5%), normoweight 7 patients (35%), overweight 6 patients (30%), obesity 6 patients (30%). Mean skin to stone distance (SSD) was 87.56 mm. Stone free rate was 55%, and difficulties during surgery only seen in 1 patient (5%) bleeding profusely and open surgery was performed. Clavien score in these patients were grade I in 11 patients (55%), grade II in 7 patients (35%), and grade IIIB in 2 patients (10%). The BMI had no significant effect with Intra operative and postoperative difficulties (0.390.  $p < 0.05$ . CI 95%). However the lower stone free rate had significant effect (0.040.  $p < 0.05$ . CI 95%). **Conclusion:** BMI had no significant effect with Intraoperative and postoperative difficulties in PCNL. However, the lower stone-free rate risk associated with elevated BMI was significant.

**Keywords:** Body mass index, percutaneous nephrolithotomy.

## ABSTRAK

**Tujuan:** Mengidentifikasi hasil dan komplikasi percutaneous nephrolithotomy (PCNL) pada pasien dengan berbagai indeks masa tubuh (IMT) dan menentukan keamanan dari prosedur ini pada pasien dengan IMT yang tinggi. **Bahan & cara:** Penelitian prospektif observasional analitik pada pasien yang menjalani PCNL antara Februari hingga Juli 2015 di ruang operasi RSUD Dr Soetomo Surabaya. Secara khusus, IMT, angka bebas batu, kesulitan selama operasi, komplikasi berdasarkan Skor Clavien dinilai. Kami mengevaluasi kontribusi independen dari IMT sebagai prediktor hasil. **Hasil:** Sebanyak 35 pasien yang dipilih dengan batu ginjal dan direncanakan untuk PCNL, 20 pasien memenuhi kriteria inklusi dan 15 pasien dieksklusikan dari penelitian ini. Para pasien terdiri dari 10 laki-laki (50%) dan 10 perempuan (50%). Rerata usia adalah 47.55 tahun (kisaran 33-75). Sejumlah 4 pasien didapatkan diabetes (20%), dan 10 pasien dengan hipertensi (50%). Rerata ukuran batu itu 23.30 mm. Lokasi batu adalah 11 pasien (55%) di ginjal kanan, dan 9 pasien (45%) di sebelah kiri. Ada 12 pasien (60%) dengan batu single, dan 8 pasien (40%) dengan batu multiple. Nilai indeks massa tubuh dibagi atas underweight 1 pasien (5%), normoweight 7 pasien (35%), overweight 6 pasien (30%), obesitas 6 pasien (30%). Rerata jarak antara kulit dengan batu (SSD) adalah 87.56 mm. Angka bebas batu adalah 55%, dan kesulitan selama operasi hanya terlihat pada 1 pasien (5%) terjadi perdarahan massif dan dilakukan operasi terbuka. Skor Clavien yang didapatkan adalah derajat I sebanyak 11 pasien (55%), derajat II 7 pasien (35%), dan derajat IIIB pada 2 pasien (10%). IMT tidak memiliki pengaruh yang signifikan dengan kesulitan saat PCNL dan komplikasi pasca PCNL ( $p > 0.05$ . CI 95%). Namun IMT memiliki pengaruh yang signifikan terhadap angka bebas batu (0.040.  $p < 0.05$ . CI 95%). **Simpulan:** IMT tidak berpengaruh signifikan dengan kesulitan intra operatif dan kesulitan pasca operasi dalam PCNL. Namun, angka bebas batu yang diperoleh semakin rendah dengan peningkatan IMT dan hal ini bermakna signifikan.

**Kata kunci:** Indeks massa tubuh, percutaneous nephrolithotomy.

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## INTRODUCTION

Percutaneous Nephrolithotomy (PCNL) was first performed by Fernstorm dan Johansson in 1976.<sup>1</sup> In the last 30 years, PCNL has largely replaced open surgery and offers a minimally invasive approach for the treatment of upper urinary tract stones.<sup>2,3</sup>

Indications for PCNL are renal pelvic stones, staghorn stones, superior calyx stones with size > 20mm, Calix stone inferior calyx stones > 15 mm, and stones of more than 1 calyces.<sup>4-8</sup>

Compared to open surgery, PCNL allows patients less bleeding during surgery, less hospitalization time, quicker convalescence and better renal function.<sup>9</sup> Stone-free rates for non-staghorn renal stones approach 84% with PCNL as compared to 62% with open nephrolithotomy. And for staghorn renal calculi, stone free rates reach 65%.<sup>10,11</sup>

Individuals with elevated body mass index (BMI) are at an increased risk of cardiovascular complications, hypertension, and diabetic.<sup>12-16</sup> Furthermore, obesity and weight gain have been demonstrated to increase the risk of nephrolithiasis.<sup>17</sup> Several studies have also shown obesity to be an independent risk factor for surgical complications, like higher risk for anastetic complication and complication related to the patient position during PCNL.<sup>18</sup>

Challenges with obtaining percutaneous access in elevated BMI patients is not easy. The limitations during surgery are multiple. Limitations with the penetration of X-ray and other intra-operative imaging. Secondly, The distance between the skin and the targeted stone is greater due to the girth of the patient. Lastly, limitations on the length of working sheaths, nephroscopes, working instruments, and lithotriptors are routinely found.<sup>15,18</sup>

Clinical Research Office of The Endourological Society (CROES) concluded that PCNL is safe for patients with obesity. The difficulty is encountered longer operating time with higher possibility from second look nephroscopy than normal BMI.<sup>12</sup>

## OBJECTIVE

We identified outcomes and complications of percutaneous nephrolithotomy (PCNL) in patients of various body mass indices (BMI) to determine the safety of this procedure in patients with elevated BMI.

## MATERIAL & METHOD

The analytic observational prospective study of patients who underwent PCNL between February to July 2015 in the operating room Soetomo General Hospital Surabaya.

Preoperative, intraoperative and postoperative factors were observed. Preoperative variable included body mass index (BMI) measurement. Intraoperative factors assessed were difficulties during surgery and intraoperative complications. Postoperative analysis included targeted Clavien scores to evaluate post-operative complications and stone-free rate.

The classification of body mass index (BMI) are ideal body weight (BMI < 25 kg/m<sup>2</sup>), overweight (BMI 25-29 kg/m<sup>2</sup>), obese (BMI 30-39 kg/m<sup>2</sup>) and morbidly obese (BMI ≥40 kg/m<sup>2</sup>).

The difficulties include single/multiple puncture, bleeding, false route, longer operating time, and conversion to open nephrolithotomy.

This research inclusion criteria are patients with renal stones > 20 mm or stones size < 20 mm in lower pole kidney, unsuccessful stones removal with ESWL, patients with abnormal kidney function without hemodialysis, and willing to follow the study and signed an agreement. The exclusion criteria are patients with stones < 20 mm in upper pole kidney that indication for ESWL, abnormal congenital kidney, patients with abnormal function of kidney that need hemodialysis, and residual stones.

All tests were evaluated at a 0.05 significance level. Complications were graded from 1 to 5 in a standardized fashion, according to the Clavien classification system.<sup>19-21</sup> Data obtained from ordinal data and carried out by Spearman correlation test method.

## RESULT

The study was conducted from February - July 2015 to 35 patients with kidney stones whose planned for percutaneous nephrolithotomy (PCNL) in Soetomo Hospital. From 35 patients, we found 20 patients who match inclusion criteria, while 15 other patients were excluded. 10 patients were excluded with history of kidney stones surgery and 5 patients refused to follow the study.

Twenty patients whose met the inclusion criteria were ten men and ten women. The youngest age is 33 years old and the oldest is 75 years with an

average age of 47.55 years. Diabetes mellitus was found only in 4 patients (20%), while hypertension was found in 10 patients (50%).

Eleven patients (55%) were found with right kidney stones, and 9 patients (45%) was found with left kidney stones with an average stone size is 23.30 mm, while 12 patients (60%) with single stone, while 8 patients (40%) with multiple stones.

The body mass index were measured and classified from WHO classification. The higher body mass index is directly proportional with the size of the skin to stone distance (Skin to stone distance/SSD). 1 patient (5%) were found with underweight, 7 patients (35%) with normoweight, 6 patients (30%) with overweight and obesity in 6 patients (30%). The average BMI in this study is 26.76, and the average SSD is 87.56 mm.

The patients who underwent PCNL with a single puncture the kidney are 8 patients (40%), while the others (60%) was performed multiple puncture. Renal puncture related with percutaneous access, and directly proportional with the length PCNL operating time. The average bleeding that occurs was 740.50 ml and 119 minutes average for operating time.

The complications were perforated kidney, false route, and uncontrolled bleeding which performed open surgery. From 20 patients were not found perforation or false route. Only 1 patient (5%) occurs severe bleeding, and open surgery was performed. The stone free rate was 55%, and the Clavien grade I (55%), stage II (35%) and the degree IIIB (10%).

From the data above shows a significant influence from BMI with metabolic disorders (diabetes) and the skin to stone distance (SSD), which is marked with a p-value less than 0.05. Whereas other variables such as hypertension, duration of surgery, bleeding, kidney puncture, stone-free number and degree of complication is not significant.

From Spearman correlation data test, we obtained a body mass index was significantly influenced by the stone-free rate (SFR), and skin to stone distance (SSD). The value of significance used was p less than 0.05 with a value of 95% confident interval. Then, to determine the factors that affect the rate of stone free on this research, Spearman correlation test - rho. Here are shown the results of the correlation test.

The body mass index had no significant effect with Intra operative and postoperative difficulties (0.390,  $p < 0.05$ , CI 95%). However the lower stone free rate have significant effect (0.040,  $p < 0.05$ , CI 95%).

**Table 1.** Data characteristic.

Variable	Description
Sex	
Male	10
Female	10
Comorbid	
Diabetes Mellitus	4 (20)
Hipertension	10 (50)
Age	
Mean	47.6 ± 10.95
Stone size	
Mean	23.3 ± 8.47
Stone side	
Right kidney stone	11 (55)
Left kidney stone	9 (45)
Number of stone	
Single	12 (60)
Multiple	8 (40)
Body Mass Index (BMI)	
Underweight	1 (5)
Normoweight	7 (35)
Overweight	6 (30)
Obesity	6 (30)
Skin to Stone Distance (SSD)	
Mean	87.6 ± 18.43

**Table 2.** During and post PCNL variable.

Variable	Description
Number puncture	
Single	8 (40%)
Multiple	12 (60%)
Bleeding	
Lowest volume bleeding	180 ml
Highest volume bleeding	2500 ml
Mean bleeding	740.50 ml
Operation time	
Fastest	45 minute
Longest	210 minute
Mean operation time	119 minute
Complications	
Perforated	-
False route	-
Open surgery	1 (5%)
Stone free rate	
Clean	11 (55%)
Residual	9 (45%)
Clavien score	
Grade I	11 (55%)
Grade II	7 (35%)
Grade IIIA	-
Grade IIIB	2 (10%)
Grade IV	-
Grade V	-

**Table 3.** Mean SSD, total puncture of the kidney, bleeding amount, operating time, and the degree of complications in IMT classification.

	BMI			
	Underweight	Normoweight	Overweight	Obesitas
SSD	61.66 mm	78.11 ± 9.28 mm	83.92 ± 13.63 mm	106.56 ± 17.11 mm
Kidney puncture				
Single	100%	42.85%	33.33%	50%
Multiple	-	57.14%	66.66%	50%
Bleeding	300 ml	568.57 ± 294.52 ml	721.67 ± 714.15 ml	1033.33 ± 1137.83 ml
Operation time	105 mnt	124.29 ± 42.37 mnt	92.50 ± 55.20 mnt	141.67 ± 39.45 mnt
Degree of complication (Clavien)	1	1.85 ± 0.69	1.33 ± 0.51	1.50 ± 0.83

**Table 4.** Correlated test in BMI with stone free rate, operating time, bleeding, kidney puncture, complications, and SSD.

	Underweight	Normoweight	Overweight	Obesitas	p	r
Stone free rate	-	42.85%	83.33%	50%	0.040	0.46
Operating time	105 mnt	124.29 ± 42.37 mnt	92.50 ± 55.20 mnt	141.67 ± 39.45 mnt	0.622	0.118
Bleeding	300 ml	568.57 ± 294.52 ml	721.67 ± 714.15 ml	1033.33 ± 1137.83 ml	0.688	0.096
Kidney puncture					0.526	-0.151
Single	100%	42.85 %	33.33 %	50%		
Multiple	-	57.14 %	66.66 %	50%		
Complications (Clavien score)	1	1.85 ± 0.69	1.33 ± 0.51	1.50 ± 0.83	0.431	-0.186
Skin to stone distance (SSD)	61.66 mm	78.11 ± 9.28 mm	83.92 ± 13.63 mm	106.56 ± 17.11 mm	0.002	0.650

**Table 5.** Stone free rate factors.

	Stone free (n = 11)	Residual stone (n = 9)	p	r
Skin to stone distance (SSD)	91.63 ± 20.18	82.59 ± 15.71	0.318	0.235
Kidney puncture	0.55 ± 0.52	0.67 ± 0.50	0.605	-0.123
Operating time	113.18 ± 42.20	126.11 ± 53.43	0.557	-0.140
Bleeding	502.73 ± 550.89	1031.11 ± 869.24	0.025	-0.500
Stone size	20.84 ± 8.28	26.31 ± 8.15	0.165	-0.323
Clavien score	1.18 ± 0.40	2.00 ± 0.70	0.007	-0.617

## DISCUSSION

In patient that planned to have surgery, high BMI can increase risk for bigger complication. Beside that surgery can also more difficult.<sup>13</sup> Extracorporeal Shock Wave Lithotripsy (ESWL) not suggested because of limitedness toward patient weight and long distance stone to the skin that cause wave focus difficult to reach the stone. Because of this reason Percutaneous nephrolithotomy (PCNL) become the choice.<sup>13,22</sup> Higher BMI creates more difficulties when perform PCNL, especially in make and maintain percutaneous access.<sup>18</sup> In this research PCNL done in prone position, and there is no patient experience respiration disturbance because of breath compression and venous return.<sup>22</sup> Percutaneous access is important component in PCNL, mainly in patient

with obesity that known for bad tolerance about bleeding dan respiration disturbance.<sup>12</sup> Kidney puncture below ribs with kidney lower pole as the target, to avoid pleura injury. Even puncture target in the lower pole of the kidney, still there is a chance of injury although the percentage not as big as upper pole of the kidney puncture. Incidence of pleura injury in the lower pole of the kidney is 4,5% meanwhile in upper pole is 16%.<sup>23</sup> In this research single puncture is successfully done to get percutaneous access in about 40% of the samples. Meanwhile the multiple puncture is successfully done in the 60% of the samples, however without injury to the pleura and other organs. Percutaneous access also connected to the duration of the surgery. More puncture to the kidney will prolong surgery duration.<sup>12</sup>

**Table 6.** Comparison of the surgery duration.

	Fuller Research <sup>12</sup>	This research
Normoweight	82.1 ± 48.3 minutes	124.29 ± 42.37 minutes
Overweight	78.9 ± 41.8 minutes	92.50 ± 55.20 minutes
Obese	84.9 ± 44.8 minutes	141.67 ± 39.45 minutes

Bleeding in PCNL caused by multiple puncture, puncture to the upper pole of kidney, less experienced surgeon, solitary kidney and staghorn stone.<sup>23</sup> In this research found bleeding about 180–2500 ml, bleeding mean about 740.50 ml. Tranfusion about 35% and open exploration in one patient because of massive bleeding and performed renorrhaphy. Bleeding and blood transfusion in this research possibly because of multiple kidney puncture, surgeon experience, and staghorn stone. As explained in other literature stone with size more than 40 mm increase the risk of massive bleeding.<sup>23</sup>

Complication in this research are stage I (55%), stage II (35%) and stage III (10%). There is no patient in need for ICU care, no urosepsis or death. Based on this findings patients with higher body mass index are safe.

From body mass index statistical test, found that body mass index only differ significantly with parameters the measured before surgery like diabetes mellitus ( $p = 0.032$ ) and increase the distance between stone and the skin ( $p = 0.026$ ). Another parameter that significant is distance between stone and the skin (SSD). Meanwhile from Spearman – rho correlation test show that body mass index has significant influence with stone free rate ( $p = 0.04$ ) and SSD ( $p = 0.002$ ). Body mass index has no influence with another parameter like kidney puncture, bleeding, surgery duration and post surgery complication degree ( $p > 0.05$ ).

In this research stone free rate in obesity group about 50%. Concerning stone free rate, we commit spearman – rho comparison test to see factors that influence stone free rate. From the test we got bleeding ( $p = 0.025$ ;  $r = -0.500$ ) and clavian score ( $p = 0.007$ ;  $r = -0.617$ ) that had correlation with stone free rate. More bleeding and higher complication degree will lower stone free rate.

## CONCLUSION

BMI have no significant effect with Intraoperative and postoperative difficulties in PCNL. However, the lower stone-free rate risk associated with elevated BMI was significant.

## REFERENCES

1. Fernstorm I, Johansson B. Percutaneous extraction of renal calculi. In: Baert AL, Boijesen E, Fuchs WA, Heuck FHW, editors. *Frontiers in European Radiology*, 1<sup>st</sup> Ed, Springer-Verlag Berlin Heidelberg; 1982. p. 1-24.
2. Morris DS, Wei JT, Taub DA. Temporal trends in the use of percutaneous nephrolithotomy. *J Urol*. 2006; 175: 1731–6.
3. Pearle MS, Calhoun EA, Curhan GC. Urologic diseases in America project: urolithiasis. *J Urol*. 2005; 173(3): 848–57.
4. Pearle MS, Lotan Y. Urinary-lithiasis: Etiology, epidemiology, and pathogenesis. In: Kavoussi LR, Partin AW, Novick AC, Peters CA, Wein AJ, editors. *Campbell-Walsh Urology*, 10<sup>th</sup> Ed, Elsevier-Saunders; 2012. p. 1257-410.
5. Turk C, Knoll T, Petrik A. Guidelines on Urolithiasis. In: *European Association of Urology Guidelines*, 2014 Ed. 2014. p. 1124–221.
6. Armitage JN, Irving SO, Burgess N. Percutaneous nephrolithotomy in the United Kingdom: result of a prospective data registry. *European Association of Urology (internet)*. 2012 January (Cited January 2012); 61 (2012): (about 6 pp.). Available from: <http://www.sciencedirect.com>
7. Seitz C, Desai M, Hacker A. Incidence, prevention, and management of complications following percutaneous nephrolithotomy. *European Urol*. 2012; 61: 146-58.
8. Park S, Meng M, Stoller ML. Percutaneous Nephrolithotomy: Technical Aspects. In: Stoller ML, Meng MV, editors. *Urinary Stone Disease: the practical guide to medical and surgical management*. Humana Press: New Jersey; 2007. p. 621-38.
9. Agrawal MS, Singh SK, Singh H. Management of multiple/staghorn kidney stones: Open surgery versus PCNL (with or without ESWL). *Indian J Urol*. 2009 April-June; 25(2): 284-5.
10. Denstedt JD, Razvi HA, Dushinski J. Percutaneous treatment of large and staghorn renal calculi. *J Endourol*. 1996; 10(Suppl 1): S140, P11–328.
11. Preminger GM, Assimos DG, Lingeman JE. Chapter 1: AUA guideline on management of staghorn calculi: diagnosis and treatment recommendations. *J Urol*. 2005; 173(6): 1991–2000.
12. Fuller A, Razvi H, Denstedt JD. The CROES percutaneous nephrolithotomy global study: the

- influence of body mass index on outcome. *J Urol*. 2012 July; 188: 138-44.
13. Alyami FA, Skinner TA, Norman RW. Impact of body mass index on clinical outcomes associated with percutaneous nephrolithotomy. *Can Urol Assoc J*. 2013 April; 7(3-4): 197-201.
  14. Mazzucchi E, Vicentini FC, Marchini GS, Danilovic A, Brito AH, Srougi M. Percutaneous nephrolithotomy in obese patients: Comparison between the prone and total supine position. *J Endourol*. 2012 Nov; 26(11): 1437-42.
  15. Manohar T, Jain P, Desai M. Supine percutaneous nephrolithotomy: effective approach to high-risk and morbidly obese patients. *Journal of Endourology*. 2007 Jan; 21(1): 44-49.
  16. Hess B. Metabolic syndrome, obesity and kidney stones. *Arab J Urol*. 2012 June; 10: 268-64.
  17. Kadlec AO, Greco K, Fridirici ZC, Hart ST, Velloso T, Turk TM. Metabolic syndrome and urinary stone composition: what factors matter most?. *J Urol*. 2012 May; 80(4): 805-10.
  18. Bahrami SR, Friedlander JI, Duty BD, Okeke Z, Smith AD. Difficulties with access in percutaneous renal surgery. *Therapeutic advances in Urology* (internet). 2011; 3 (2): (about 10 pp). Available from : <http://www.sagepub.co.uk/10.1177/1756287211400661>.
  19. Dindo D, Demartines N, Clavien PA. Classification of Surgical Complications: A New Proposal With Evaluation in a Cohort of 6336 Patients and Results of a Survey. In: Lillemoe KD, editor. *Annals of surgery*, vol 240, Lippincott Williams & Wilkins; 2004(2). p.205-13.
  20. De la Rosette JJ, Opondo D, Daels FP. Categorisation of complication and validation of the Clavien Score for percutaneous nephrolithotomy. *European Association of Urology* (internet). 2012 March (Cited April 2012); 62 (2012): (about 10 pp.). Available from: <http://www.sciencedirect.com>
  21. Palmero JL, De la Rosa IN, Miralles J, Amoros A, Pastor JC, Benedicto A. Study of predictive factors for complications after percutaneous nephrolithotomy according to the Clavien classification. *Actas Urológicas Españolas* (internet). 2012 October (cited 2013); Available from: <http://dx.doi.org/10.1016/j.acuro.2012.11.006>
  22. El-Assmy AM, Shokeir AA, El-Nahas AR. Outcome of percutaneous nephrolithotomy: effect of body mass index. *European Association of Urology* (internet). 2006 November (Cited December 2006); 52 (2007): (about 7 pp). Available from: <http://www.sciencedirect.com>
  23. Taylor E, Miller J, Chi T, Stoller ML. Complications associated with percutaneous nephrolithotomy. *Transl Androl Urol*. 2012 Oct; 1(4): 223-8.